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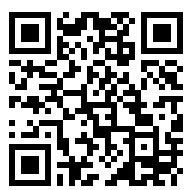

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THE ROYAL ENGINEERS JOURNAL.

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JANUARY TO JUNE 1906.

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THE ROYAL ENGINEERS JOURNAL.

Vol. III. No. 1. JANUARY, 1906.

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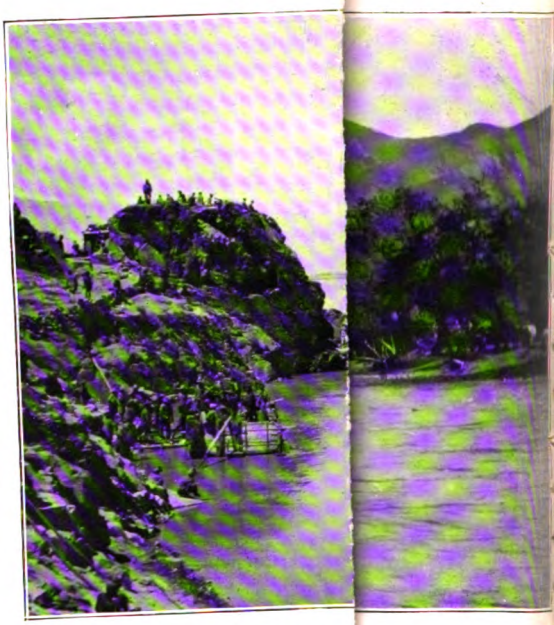

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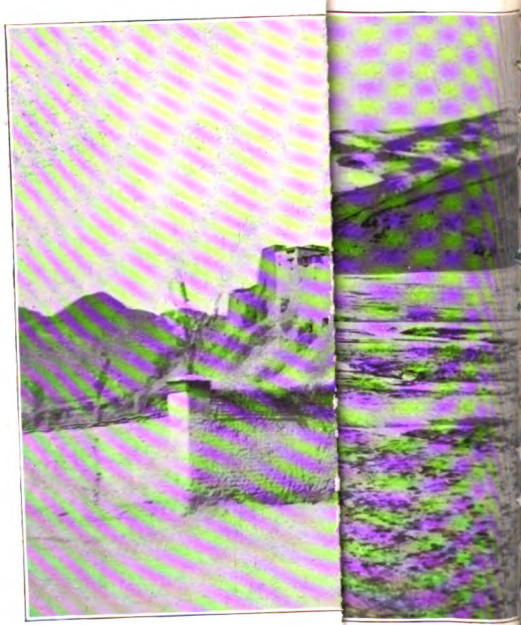

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THE ORGANISATION OF THE RAILWAY DEPARTMENT IN WAR.

By Capt. J. W. S. Sewell, R.E.

The Organisation of the Railway Department in War constitutes an interesting study for the R.E. officer, inasmuch as it presents many of the conditions to be met with in the war organisation of the Corps generally.

When the principles of such an organisation are laid down in peace, the system chosen must be of a sufficiently elastic nature to be altered without difficulty to meet the varying conditions of British campaigns. The history of the construction of such a system is given in detail in *The History of the Railways in South Africa*, 1899—1902. But it is somewhat obscure to the casual reader, and this article is an attempt to formulate the results and to deduce the lessons contained.

Previous to 1896 the British army had no practical experience of any value in the use of railways in war. In the years 1896–99 the Soudan Military Railway was constructed and worked by R.E. officers. The lessons then learnt and those taught by the Franco-Prussian war of 1870 were applied in the administration of the railways in our South African war of 1899—1902, until a system was evolved that may well be regarded as a model for future campaigns. This organisation had to deal in a greater or less degree with all the more important problems which could confront a Director of Railways. These are (*vide* "Railways in War" by Sir Percy Girouard, in *R.E. Journal*, July, 1905) :—

(1). The control of railways in a friendly country worked by a friendly staff.
(2). Reconstruction ; that is, the repair of damaged lines.
(3). The construction of a new railway or railways.
(4). The working of railways in a hostile country.

Any or all of these duties may have to be undertaken. It is therefore best to frame the requisite organisation for the maximum work required. It can then easily be modified to meet the requirements of any special case. The following Table gives a general idea of such an organisation.

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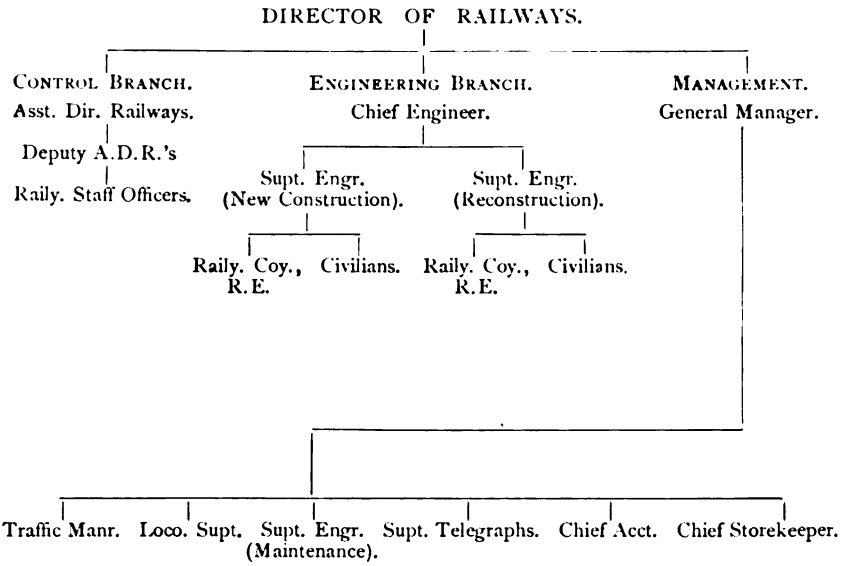

It will be noted that in the Table consideration of detail, such as control of finance, etc., is omitted. Furthermore, varying conditions will of course modify the system. For example, the D.R. might personally direct the control branch, or act as General Manager of the working branch. Again, the importance of the engineering branch will, as time progresses, vary inversely as that of the working branch; it may well happen that the engineering branch can be put at once under the G.M., and a time will certainly come when this must be done. But the principles will remain unaltered as regards the employment of the railway units and R.E. officers.

Let us consider the case of the Railway Companies, R.E. In the above system we see the relegation of these units to their proper function :—construction work. Until lately the objective in view in training these units appears to have been their expansion in war into an administration to construct, maintain, and work a 2′ 6″ steam tramway. Recent campaigns have shown this to be too restricted a view, and have assigned to the railway department a far more ambitious *rôle*, in which the steam tram plays no part.

In a Railway Company in future campaigns we shall need a few specialists to work the small section (in advance of the furthest open station) which is in charge of the construction engineer and has not yet been handed to the management of the open lines, and also to find the technical staff for armoured trains. The remainder must be "construction" sappers. In peace there is a tendency towards the sapper working too much at his one trade. We want "handy" men : as one officer puts it, "we want one trade in the Corps,—that of making things." It would, I fear, be considered heretical if it were

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suggested that the rank and file of the Corps should be rated as sappers; but were this done, it is at least doubtful if it would affect either recruiting or our standard as much as is sometimes suggested,—bearing in mind the very excellent pay and advantages now offered. A company of specialists is economically unsound as is the recognised fact with a small workshop: for only a portion of the trades are of use at any one time. Handiness is essential in the railway sapper.

Experience has proved that the military qualities and discipline of the R.E. regulars are essential for front line construction or re-construction work; but the finishing touches, of the nature of permanent bridges, buildings, etc., can be put on in rear of the front line and, where the communications are reasonably immune from hostile attack, by corps of civilians or specially enrolled troops. In countries where coolie labour exists such labour will be utilised to assist the sappers by performing the unskilled labour for them.

Before leaving the subject of railway construction it is necessary to mention the use of tramways. As an introduction to this it is expedient to digress for a moment to discuss a matter which does not appear to be clearly understood by some officers, viz.:—gauge. Distinction must be made between a railway and a steam tram. The contingency of the latter ever being required, even for some very local purpose, is remote in any case, and a branch railway or siding would usually be far more useful. To avoid breaking transit the gauge of the country must be adopted if railways already exist. In the few cases where they do not exist, and where it is improbable that connection will ever be made with any existing system, various factors have to be considered and balanced:—

(1). The possibility of rapid construction.

(2). Maximum train loads are essential factors. The load will increase nearly as the cube of the gauge, but a restriction is imposed by the necessity for rapid construction.

(3). Existing rolling stock must be available in large quantities. There are practically four standard gauges:—5′ 6″ (India), 5′ 0″ (Russia), 4′ 8½″, and 3′ 6″. For the 5′ 6″, 4′ 8½″, and 3′ 6″ gauges rolling stock would always be available, and perhaps for a mètre gauge. As the construction of rolling stock is a slow process, building a railway for which existing rolling stock is not at once available would be similar to engaging in a naval war without having first acquired a fleet.

The conception of a steam tram presumably arose from the idea that a narrow gauge was necessary for siege purposes; but here again a branch line of normal gauge would probably be more advantageous (*vide* "Railways in War" quoted above). There is however a distinct use for a horse tram. When an army halts for any period in excess

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of three or four days on such a frontage as (say) 30 miles, the flank corps will be at a distance from rail-head that would be most exhausting to supply columns resorting thereto to replenish their stocks. It might then be advisable to bring up a very light "Decauville" tramway, 18″ or 2′ gauge, with 14-lb. rails and light trucks: this could be laid rapidly across almost any country in a manner and on grades which, while not permitting the use of locomotives, would enable trams to be drawn by animal transport, thus obviating exhausting haulage of wagons along (probably) indifferent roads. The work of laying such tramways should be entrusted to the Field Engineers.

The employment of R.E. Officers may now be considered. It is an axiom that in war a surplus of R.E. officers is required. In peace state employment is found for such officers,—in our army in fortification and barrack maintenance work. It is perhaps unfortunate that the necessary circulation of officers and the consequent rotation of duties, whilst tending to produce a "handy" officer, militates against "specialising." Generally speaking, in fact, there is as much tendency for an officer to be handy at the expense of specialisation as there is for the sapper to be a specialist at the expense of handiness. Be that as it may, the necessity is here apparent for the supply in war of specialist railway officers from the surplus. They would be sent out as special service officers, not as extra officers of railway companies. In the above organisation there is room for a number of such officers: to mention only a few—the Director, Assistant Director, and some of the Control staff; the Chief Engineer and his subordinates; the General Manager and his Loco. Supt., Supt. Engineer, Supt. Telegraphs, and other junior officers.

To recapitulate, there is a R.E. officer at the head of the department, with a staff of special service R.E. officers, and with R.E. companies in the first line (on the Lines of Communication), and a second line of civilian or quasi-military corps.

It is interesting to consider what would be the effect of introducing an analogous war organisation for the R.E. generally. If such a system could be adopted for the Field Engineers we should have a large supply of extra R.E. officers sent out to the Chief Field Engineer in such numbers as might be necessary for the campaign in hand. These officers would then be "in hand" for use as required; whereas, if they are told off beforehand to Divisions or as extra officers for R.E. units, there may easily be a surplus at one point and a deficiency at another where they are badly needed. In South Africa there appeared to be some consensus of opinion that there were too many R.E. officers with (for example) an Infantry Division; whilst certainly on the L. of C. the junior officers in the early part of the war were frequently in need of the control and support of a senior.

There is on the L. of C. a mass of engineering work to be done in

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preparing or superintending the defences, water supply, etc., of camps, stations, and posts, the maintenance and improvement of communications, and the erection of semi-permanent buildings, such as hospitals, huts, bakeries, remount buildings, etc. The hasty work of the front line, such as temporary bridges, field engineering generally, field telephone communications, and field tramways, will vary so much with the nature and locality of each campaign that the principle of fixing the numbers of R.E. in the front line by the number of infantry would seem worthy of reconsideration. Under a system similar to that adopted for the railway department, only such R.E. units would be sent forward at first into the front line as the nature of the campaign required, the remainder being allotted to Sections of the L. of C. These latter units and a second line of civilians, under C.R.E.s of Sections, would carry out the more permanent work indicated above.

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COMMUNICATIONS.

By Capt. J. E. E. Craster, R.E.

Once upon a time an eminent authority gave it as his opinion that tactics changed every ten years. Had this rate of change remained constant, tactics would now be reckoned among the most immutable of military affairs. The statement however was made at a period when the weapons employed changed but little, and when consequently there was no obvious reason for a change in tactics unless it was brought about by a variation in the quality or number of the troops employed or in the skill and experience of their leaders.

In modern times weapons improve so rapidly in range, accuracy, and rate of fire that a rifle or gun is obsolete in one or more of these qualities almost before it leaves the arsenal. All these improvements necessitate correspondingly rapid modifications in tactics, but it is to be feared that the tacticians are not able to keep pace with them. The theory of tactics does not alter much if at all, it is the practice that becomes each year more circumscribed; every year movements that used to be easy become difficult; what is difficult to-day will to-morrow be impossible. It reflects little credit on the imagination or forethought of tacticians as a whole that every new fire effect has caught them napping; although the quality of each new weapon is accurately and widely known, the modifications in formations and manœuvres that its adoption must produce are rarely foreseen, never provided for.

If we go back a hundred years and compare the parts played by the commander of a force then and now we shall appreciate what great modifications modern developments have produced even in this one *rôle*. Accounts of the campaigns of the last century do not give us many glimpses of the great commanders during the actual progress of their battles; but on the few occasions when they are visible through the clouds of smoke they are nearly always occupied in the same way, namely in personally supervising the movements of their troops; apparently it was their normal occupation. Sometimes we discover them leading the general reserve to deal the decisive blow, sometimes they are withdrawing men in ones and twos from the less threatened portions of the line to organise a local counter-attack.

It is clear that the dispositions of the troops were perpetually modified and adjusted by the commander in person to suit the exigencies of the moment. This was an ideal state of affairs, but it

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cannot be approached under modern conditions; the forces engaged are too large, the extent of the battlefield is too enormous, the intensity of modern rifle fire is too deadly, for the principal commanders or their staff officers to ride hither and thither and arrange the troops to their liking.

Modern developments have driven the Commander-in-Chief off the battlefield. He will probably be found in a quiet country house miles from the scene of action, and the only external evidence that this house contains the directing power of the army will be the large number of telegraph and telephone wires radiating from it. The days when a Commander-in-Chief could lead the final cavalry charge have gone for ever. The commander of any considerable force who takes a personal part in the fray forthwith abandons his command. His action is not war; it is not even magnificent.

However this is neither the place nor the time to lay down what a commander shall and what he shall not do. The above arguments were brought forward to convince the reader that the old *rôle* is impossible, so that he might more readily acquiesce in the development of the new. If a commander is to keep in touch with all the component parts of a vast army distributed over anything from twenty to a hundred miles of country, it can only be by the help of a network of telegraphs and telephones. It is the duty of the Engineers to arrange the system and to maintain it in working order; on us now depends the connection between the brain and the body of an army, and the exclusion of the commander from the battlefield has enormously added to our burden of work and responsibility.

The closer we approach to the firing line the more difficult becomes the transmission of orders, until at last we arrive at a point where, even if orders can be conveyed to the troops concerned, it is almost impossible for them to carry out any movements whatever. The development of artillery and rifle fire has deprived troops within the fire zone of most of their manœuvring power. Where the fire is most intense they must lie motionless throughout the day; in more favourable positions they may be able to crawl about a little and to advance or retire by slow degrees; but to manœuvre, in the old sense of the term, within range and view of the enemy is impossible.

Yet this lost power of manœuvring can to some extent be restored by artificial means and by taking advantage of natural cover. Complete mobility and secrecy can only be ensured by continuous cover from view; cover from fire is of no immediate tactical importance, and we may regard it, for the present, as merely a concession to the craving of the individual for personal safety.

Where the personal element is eliminated we find screens of cornstalks erected instead of earthen parapets. Such cornstalk screens, erected under the supervision of the Japanese General Staff, had a great tactical value because they served to mystify and mislead the

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enemy ; they were objects of little interest to the individual Japanese soldier because they would not stop a bullet.

The battle of Mukden, however, gives us an example of a form of cover which had little tactical value but which was an object of great solicitude on the part of one individual. A Japanese soldier went into battle carrying a Gladstone bag filled with stones. The fact that it was portable, and therefore did not destroy the mobility of its owner, did give it some slight tactical interest and rendered it far preferable to a shelter trench ; there however its tactical value ceased ; its individual interest lay in the fact that it was bullet-proof. Unfortunately the owner of the bag did not survive the battle. Whether he was shot as he peered round the right-hand bottom corner, or whether the bag finally let a bullet through, or whether he met his fate as he advanced bag in hand, history does not relate.

The point to be illustrated and emphasized is this :—Cover which has only a tactical value must be thought out and arranged for by the Staff, more particularly the Engineer Staff, otherwise it will be neglected ; cover which is of immediate and obvious value to the individual will be arranged for and provided by the troops themselves after they have been under fire a few times. Seasoned troops will spontaneously entrench themselves, but they cannot be expected to make or arrange for covered communications on any adequate scale ; this is the business of the engineers.

The increasing range and accuracy of modern weapons render the necessity for covered communications every day more urgent. A general can ask for no greater boon than the power to reinforce or withdraw his troops, unobserved and unmolested by the enemy, at any and every point along his position ; and conversely his chief desire must be to deprive the enemy of this power.

Doubtless all the readers of this *Journal* know by heart the twelve chief requisites of a defensive position as stated in this year's *Combined Training ;* and they will remember that the seventh on the list is :— "Sufficient depth and good lateral communications in rear of the entrenchments, so as to allow the covered passage of troops to any desired point."

It is a pity that all the twelve requisites could not be numbered "one," for though they may not all be equally important they must all be considered together ; above all the question of communications must not be left to the last. Troops armed with modern rifles can hold almost any ground if they are properly entrenched ; in selecting a position it is therefore possible to allow the question of communications more weight than formerly. Unless you consider your lateral communications from the very first you will neglect them ; if you neglect them then, when the pinch comes you will find your troops are earthbound, divided and helpless, unable to concentrate for either attack or defence, caught like rats in a trap, to be exterminated at

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leisure by your victorious enemy. An isolated length of shelter trench bears more than a superficial resemblance to a grave.

This is an additional reason why this subject should receive the particular attention of military engineers. The chief drawback to the use of field defences is that they tend by their moral effect to render the troops using them immobile; if in addition the communications are faulty, the works may form very concrete obstacles to mobility. It is essential that the engineer should recognize this tendency and combat it by every means in his power. Works designed by him or executed under his supervision should, by the completeness of their communications, become aids to mobility and obstacles only to the enemy.

The question that has inspired this rambling and disjointed discourse is this:—how to restore to a modern force its lost mobility; how to preserve it as a mobile and coherent body, so that it may fight, manœuvre, and fight again as long as human endurance render movements and fighting possible. The answer to this question is good communications. Communications include telegraphs, railways, roads, trenches, and screens; all these are, for the present at any rate, in our charge. An inexorable destiny—nothing less, in fact, than the advance of civilization—is placing the 'ordering' of the battle more and more in the hands of the engineers. It is for us to recognise that destiny and to prepare for it; nothing that calculation or forethought can supply must be left to chance.

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EXPERIMENTS ON ROAD SURFACES.

By Bt. Col. H. de H. Haig, R.E.

The dust and mud on the roads about Brompton Barracks, Chatham, have long been a source of annoyance, which called for some remedy. Experiments have therefore been carried out recently with a view to improving road surfaces, and to making them suitable for all sorts of traffic.

As the road passing the Institute was being re-made at the lower end, the opportunity was taken to carry out a series of trials to ascertain what is the best material to bind the surface and throw off water.

(1). The first thing tried was Westrumite, which has been much advertised for the purpose. £10 was spent on its purchase, and £10 more for sprinkling it over an area of about 1,200 square yards. The result was not satisfactory. It did lay the dust almost entirely at first; but the effect very soon wore out, and in two months' time one could not tell that it had ever been applied.

(2). Next a piece of road, about 500 yards long and 30 feet wide, was bottomed with 6 inches of large stones and brick burrs, and then covered with 4 inches of broken granite, 2-inch gauge. This was rolled, without any binding material whatever, until the whole surface was thoroughly hard and smooth, the steam roller making no impression. Then a mixture of tar and creosote, in the proportion of 30 to 1, was heated and poured over the surface, being broomed into the interstices; this made too liquid a mixture, so the proportion of creosote was reduced by two-thirds. The tar was allowed to set for four days, and the surface once more rolled with the steam roller. The result appears to be excellent, but the cost was somewhat extravagant, being 1s. 9d. per yard super.

(3). An experiment was then tried with a road surface that had already been made in the ordinary way, with similar (but deeper) soleing and crushed granite, but filled in with fine pit gravel; this portion had been in use for over a year, and had been subjected to very severe traffic from traction engines twisting round a bend. The surface was first swept with hard brooms down to the crushed granite. Then a mixture of pitch and tar, in the proportion of 1 lb. pitch to 10 gallons of tar, was heated and poured on, being brushed in with hard brooms. It was found that this took too long in setting, and on hot days was inclined to lift. The proportion of pitch was then

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increased to 1 to 8 of tar, and some road sweepings were added for the surface. This answered for ordinary traffic; but under the steam traction engines the surface became scaly and inclined to peel off.

A mixture of 1 lb. of pitch to 5 gallons of tar was finally tried, and some road sweepings were used as a covering during the setting, the spare material being swept off on the second day. The result of this appears to be perfectly satisfactory under all traffic; there is no dust or mud, and the surface dries very quickly after rain. How long it will last cannot yet be told, but it promises well under traction-engine traffic. The cost works out to only 2½d. per square yard, which could be considerably reduced if operations were on a large scale, and proper cauldrons were available for boiling the mixture. The important condition is that the surface must be thoroughly cleaned, and the mixture put on whilst it is quite dry so that it gets a firm grip.

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HISTORIC INFLUENCE OF FOREIGN POLICY ON COAST DEFENCES.

By Bt. Col. O. E. Ruck, R.E.

That the progress of defence works has always been subject to fluctuations, both in regard to design, and also as to cost of maintenance—varying in direct proportion to the supposed strategical and economical necessities of the times—is amply proved by a cursory glance into the far-away pages of our country's story.

In some cases the invading enemy were underrated, the defences being afterwards found to be inadequate ; in others the reverse took place : but they were few.

For the purpose of this retrospect, it will not be necessary to probe too deeply into the records of the past, nor to conjure up, in imagination, works of fortification not in evidence at the present day.

A brief study, on their actual sites, of the Celtic and Brigantian hill forts now in existence in England and Scotland, constructed even so late as 55 B.C., will at once shew that either the strength of the Roman invaders was undervalued, or that time and means were not available to hand for greater efforts on the part of the defenders.

Again, the stern lessons of bitter experience—gained, as a rule after, and not before the event—determined the scale on which the strength of Roman defence works and the expenditure involved eventually had to be based.

From a study of the works themselves, we know that Agricola in 81 A.D., with a view to confining the Caledonian tribes within prescribed boundaries, built 16 detached forts of aggested earth between the estuaries of the rivers Clyde and Forth.

After-experience, however, soon proved that the original works were underestimated in point of strength ; the Caledonians, as time went on waxed exceeding troublesome, and the task of revision remained for completion by Lollius Urbicus, who, in A.D. 144, by the addition of a continuous rampart with fosse, 34 miles in length, appuied with the early forts of Agricola—now strengthened by masonry—brought the whole of the defences up-to-date. The cost of this revision amounted to some £250,000 at current civil rates of wages. The same under-estimate of works, urgently required on the part of an invading army which meant to remain in possession, was again made by Hadrian in A.D. 120, whilst engaged in raising his wall

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of forts and continuous lines between the Solway Firth and the mouth of the Tyne, a distance of 72 miles.

Owing to an unforeseen development of the strategic situation, the Meatœ tribes having joined forces with the Caledonians, a revision of the whole lines had to be made by Septimius Severus in the year 200 A.D. at an approximate cost of ¾ of a million sterling.

Coming farther south, the British defences at Dover, which commanded the antient harbour and proved sufficient to deter Julius Cæsar in B.C. 55 from landing at that place, had afterwards to be strengthened by the Romans themselves, as a necessary precaution against the depredations of the pirates of the North Sea, the Jutes, the Angles and the Saxons.

Scarcely had the Romans turned their backs on this country, when the latter people in their turn strengthened the defences against a probable Norman invasion by sea, adding thereto an outer Vallum and Fosse.

Then again the Normans, after turning and taking the defences of Dover from the land side, previously having landed at Pevensey, commenced forthwith to yet again strengthen the works in view of the next probable attack, whether it came from the land, or from the seaside ; the chances of either form of attack appearing to be about even.

In A.D. 1135—1154, Stephen being king, an insurrection in Scotland and Wales, followed by a general state of anarchy consequent on the creation of an excess of earldoms, and the building of innumerable strongholds by castle-building Barons, led to more increasing of the defences of Dover by those already in possession ; the attack which inevitably followed happened to be a combined land and sea attempt by a landing force under the Dauphin Louis of France, operating from without, aided by rebellious but more or less friendly Barons intriguing from within. This fight took place in 1216 and ended in the defeat of the attackers and their friends.

In 1223, the sum of £2,923 was spent on improved works at Dover by Henry the Third and the defences were still kept up to strength, but in 1295 their efficiency was again put to the test by a raiding force of fifteen thousand Frenchmen under Montmorenci who were put to flight.

Edward the First set great store by Dover in view of the war necessitated by a Franco-Welch-Scottish alliance in 1296. Troubles with France in the reigns of Edward the Second and Edward the Third eventually landing us in a naval defeat off Rochelle in 1372, led to much work of revision on the Dover defences, large sums being expended of which a minute record is still preserved in the public record office.

From the year 1339 up to 1483 there had been ten raids on the national defences by the French, these defences as a whole having

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been unwisely allowed to fall into comparative desuetude, thus courting attack.

It is not therefore surprising, that when Henry the Eighth entered on the scene in 1509 and engaged in military operations with Louis the Twelfth in the South of France, two successful raids were meanwhile made on the coast of Sussex by Prior John, in the course of which the English artillery was found to be outranged by that of the French. The energetic Henry at once turned his personal attention to a general strengthening of the Coast Defences of the realm; and particularly to the improvement of Ordnance, in view of future eventualities. So successful and farsighted was he, that the next French raid in 1545 on Portsmouth and the Isle of Wight was repelled by means of these new defences erected by Henry as a matter of prudence.

Amongst the many coast Ports strengthened by him were those of London and the Thames, including Gravesend Bulwark, Milton and Higham Bulwarks, East Tilbury Castle and West Tilbury Blockhouse. The increased strength of the defences constructed by this vigorous and prudent monarch effectually checked any further attempts by serious raids for more than a century.

The insurance policy thus effected by Henry, and paid for in great measure from ecclesiastical funds on the suppression of the Abbeys, sufficed for the requirements of the country during the reigns of Edward the Sixth and Mary, little or nothing being done for the defence of the coasts.

But when Queen Elizabeth came to the throne and England found herself at war with the second power in the world, the country slowly aroused itself to a conviction, that some active steps towards improving the state of the defences would be worthy of being taken into leisurely consideration.

The previous reigns had been those of great extravagance and waste, so much so that, with the financial pressure which was always weighing over England, the supplies and fortifications of Calais had been shockingly neglected and the loss of that port in 1558 inevitably followed.

In 1587, nineteen years after the accession of Elizabeth, the Round Tower at Portsmouth was reported to be so old and rotten that it was dangerous to shoot from; the forts at Gravesend and Tilbury were nearly as bad, for in July 1588 (the Armada almost in sight) we find that "there was not one platform fit to bear any Ordinance, neither on the ground nor aloft"; on the following day, however, we read that the inspecting officer "has putt these Fortes in as good strength as tyme wyll permytt."

Three years after the accession of Queen Elizabeth the Bulwark at Upnor was completed and by 1561 some form of defence existed at Queenborough and Sheerness.

In 1580, owing to the descent on Smerwick in Kerry, by Spanish and

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Italians assisting the Irish Catholics now in rebellion, emergency orders were issued that three forts must be made at Milford, viz., at Rat Island, Dale, and Stack Rock, "to be set in hande at one instante, and great expedition used upon them."

But, as is so often wont to occur at a crisis and when hasty work is required, it came to pass that no experienced fort builders were surviving. In the decadence of defences in the preceding two reigns "the cooks from long disuse forgot their trade," and fortifications according to the prescription of an Italian gentleman named Frederick Genebelli were erected to replace what had now become a lost art in our own country.

Twenty years had passed by, Elizabeth being Queen; but beyond the commencement of the defences of the Medway, and those of Milford Haven, little else had been attempted in the military works line.

In July, 1588, the English nation, relying on these new works as yet in their infancy, and also on partially patched-up forts of Henry the Eighth's time, awaited with contemptuous confidence the denouement of events; the end of the month saw the stately advance of the Spanish Armada, which, as we know, by a most fortuitous combination of circumstances was destined to ultimate dispersal and partial destruction.

The immediate crisis having passed, the next eight years afforded a short breathing space for consideration and action if so desired; but in the year 1596 a second invasion from Spain loomed up at an earlier date than was anticipated, forcing the pace, and disturbing the prevailing equanimity. Some show of action was now attempted; the Privy Council after a short deliberation issued an important Report on the "application of the wise proceedings of our ancestors to the present crisis of public safety."

This report, issued for the private information of members of the government only, at once raised a veritable maelstrom of controversial discussion carried on by Amateur Experts in public, as to which of the many undefended ports should be strengthened first, and whether any other places in their vicinity required fortifying.

Time still continued to go on, and by 1603, James being king, peace came with Spain, followed by a further decadence in the military efficiency of the defences of England; that is, until the year 1623, when, almost in the twinkling of an eye, war with Spain again appeared as a possibility to be reckoned with at an early date.

Immediate surveys were forthwith made as to the necessary repairs required to render the forts and armaments efficient, but no funds appear to have been forthcoming from the exchequer, even in spite of reiterated warnings and reports that none of the existing Forts were expected to survive the winter.

In 1625, Charles the First had mounted his throne, and the same

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complaints as to the need for revision of Henry the Eighth's constructions continued. Thus it arose, in 1627, rumours of war with France being to the fore, that the town of Dartmouth, tired of waiting for decisions, in their corporate capacity and of their own volition built themselves defences out of the rates, and further applied for powers to purchase guns to arm the same.

The military energies of the period were, however, too much absorbed in the contests of the civil war for the nation to devote much attention to coast defences, in the absence of threatening foreign attacks.

On the accession of Charles the Second in 1660, Sir Bernard-de-Gomme, a clever French military Engineer, with leanings in the direction of the Dutch School, was appointed Chief Engineer of all the King's Castles in England and Wales and commenced to revivify some of the decadent coast works already in existence. The essential element of time was however required, so that when, in the year 1666, a bolt from the blue in the unwelcome form of a war with France, Denmark and Holland suddenly appeared, it can readily be believed that in the words of Macaulay "The House of Commons willingly voted sums unexampled in our country's history" for improving old works of Coast Defences and hastily erecting new ones.

The last-mentioned descriptive method, that of "hastily erected improvised works," which has so soothing a sound to the parsimoniously inclined or the procrastinator, and which reverberates in our ears with a somewhat familiar ring, is no newly coined aphorism. Hastings in 1557 being reported as "easy to fortify at any time from its strong position," whilst in the same year the Isle of Portland "is so strong by nature that it should easily be made impregnable in a short time, by the help of a little art." Both these places could therefore well be left for future consideration.

The years 1666–7 were especially instructive, as the British Fleet was "in being," but unfortunately chiefly on paper. Charles the Second, who at the time was secretly receiving from Louis of France the sum of £200,000 a year for the privilege of acting as that king's vassal, according to Pepys "took the fatal resolution of lying up his great ships, and keeping only a few frigates on the cruise."

The public records of the period refer to the strenuous exertions made by the people, with the aid of the chief engineer Bernard-de-Gomme, to crowd into as short a time as possible as big a programme of fortifications as could be devised; including chiefly the East, South, and North-East coast defences. Doubtful Naval victories were being won alternately by the Dutch and English, and whilst negotiations for peace were in progress at Breda, De Ruyter seized the opportunity to make his famous raid on the Thames and Medway Defences; the Dutch becoming virtually masters of the mouth of the Thames and English Channel for the space of six weeks.

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This memorable raid commenced on the 9th of June, 1667, by 18 light ships and frigates with 1,000 men ascending the river Thames with the object—not, as is supposed by some, to vent their spleen on the sleek and well-nourished citizens of London—but to surprise some English ships which were reported to have sought security in the upper reaches.

On the 10th, the Dutch vessels being anchored off Hole-Haven tide and wind against them, some of the crews, strictly against orders landed on Canvey Island, stealing some sheep, and burning some insignificant barns; the same afternoon the ships weighed anchor and dropping downstream fell back on Sheerness, destroying the forts (such as they were), as well as the warships almost destitute of ammunition (which had been demanded but not yet received in full). The next day the Dutch proceeded upstream in the Medway to Upnor and Chatham, burning the *Royal James*, the *Royal Oak*, and the *Loyal London;* the *Royal Charles* they took away, running her on the mud, eventually sending her to Holland for exhibition purposes. Afterwards, the Dutch fleet went on to Harwich, stole more sheep from the lower Hope marshes, battered East Tilbury church, fought an action in the Hope with nineteen improvised on-the-spur-of-the-moment ships, which according to Brandt "set the river ablaze"; and then on the 23rd of July again went off to Harwich, where, after varying the monotony of their stay by sundry diversions of a sporting character, they remained until the declaration of peace in the end of August, 1667. What appears, at first sight, to be of rather startling a nature, having regard to the admittedly highly strung temperament of our congested town-dwellers at the present day, is the alarming effect this purely Naval raid produced on both the urban and also on the rural population of this country.

On the 9th of June, when the Dutch fleet had commenced to silently glide into the approaches of the Thames as far off as Ramsgate, Evelyn states "The alarm was so great, that it put both country and city into fear, panic, and consternation, such as I hope I shall never see again. Everybody was flying: none knew why or whither" Pepys, living in London, at once took steps to realise his property in hard cash, and sends his wife into the Hinterland with £1,000 in coin which she is instructed to bury in some secluded nook. On the 15th of June, the Dutch fleet lying quietly near the Nore buoy formulating fresh enterprises after the raid on Chatham, a city man writes "The Marchants are undone; Our great Banckers of money have shutt upp their shoppes. People are ready to teare the haires from off their heads. Wee expect the Dutch as far as Woollage; All the people are fled from Greenage and Blackwall with their families and children."

On the 17th of June, the day before the Dutch detached one of their three squadrons to raid Harwich and Aldeburgh, the feelings of

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the landsmen were somewhat chastened, for they report "these are sad and troublous times" "Ill news comes so thick that we are not able to keep up the spirits of the people; indeed we ourselves are so dejected that we can hardly conceal it." Pepys feared that the mob might burn his office and do personal violence to himself, owing to his connection with the Navy. It was reported generally that all the King's ships at Chatham had been burnt (whereas most of them were uninjured). Some said "The King was gone out of town, nobody knew whither," others, "that he was gone out of this life and (out of the world)." There were rumours that Harwich, Colchester and Dover had been burnt out by the Dutch.

This undignified scare, short and sharp as it was, soon subsided into the oblivion of the past. In James the Second's reign, 1685—1688, little or nothing was done to keep up the defences. William the Third contented himself by perpetuating his name in the erection of Fort William in order that he might overawe the Highlanders. In the times of William and Mary the usual perennial threatened invasion by the French was checkmated for a period by the Naval victory at La Hogue by Admiral Rooke in 1692, and Coast Defences were at a discount.

Pass we now to the days of amiable Queen Anne.

In the middle of this Queen's reign, chiefly owing to a projected invasion of England by the King of France, acting on behalf of the Scottish Pretender, great preparations were made for the extension of the fortifications, that is in so far as the necessary land was concerned; but the crisis passing away, no Forts were commenced. The next works of importance that were constructed took place at Chatham and Devonport in the reign of George the Second; the immediate cause being reported to have arisen by the reason of the "urgent and hostile invasion made on his Majesty's dominions in America and the Mediterranean, and the great preparations made in France for invading these realms."

In the reign of George the Third more additions were made, but for the most part they were allowed to fall into decay after the war.

Between 1790 and 1860, the year when a Royal Commission was appointed to enquire into "the present state, condition, and sufficiency of the fortifications existing for the defences of our United Kingdom," little was done beyond executing the necessary repairs.

The perusal of the historic examples enumerated, and any others which may have been omitted, invariably tell the same recurring tale, pointing as they do to the unerring sequence of a policy of close parsimony followed by lavish ill-considered and hasty outlay with regard to our Coast Defences. Great risks were continually being run during times when a happy-go-lucky, hand-to-mouth policy, chiefly due to motives of economy or greed, had permitted matters of defence to drift on, regardless of danger; the fates, on the whole, had been curiously

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propitious. The number of regrettable incidents had been large; but fewer, it is true, as time went on, owing to a steadily growing conviction that an all-powerful Navy combined with strong home defences were absolutely necessary for true economy; and also to give that freedom of action so essentially required by a Navy and Army "in being" for operations over and across the seas. Likewise as a means of preserving that peaceful security to society inhabiting these Islands, necessary for the uninterrupted flow of the world's commerce, to save disastrous pecuniary losses due to dislocation of business, and finally to obviate the degrading attitude of undignified frantic panic, which the unorganised, undisciplined civil population would be naturally inclined to adopt at a time of sudden attack or unexpected raid.

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ARE OUR IDEAS ON PERMANENT FORTIFICATION UP TO DATE?

By MAJOR H. E. G. CLAYTON, R.E.

SIR GEORGE CLARKE in *Fortification: Its Past Achievements, Recent Developments, and Future Progress*, published in London, 1890, states on p. 131 :—"Full development of rifle fire implies the abolition of traverses (which in works of the type advocated, Twydall Redoubt, are practically useless)."

It is perhaps always somewhat unfair to abstract a portion of an author's writings from its context and then to criticise it, but the statement made above appears at first sight to imply a want of appreciation of the conditions created by modern artillery and rifle fire. Sir George Clarke in the above extract no doubt refers to the large and conspicuous traverses which have taken such a large part in the composition of the parapets and ramparts of our permanent works in the past. Such traverses, except for the protection of gun emplacements, are no doubt practically useless; but modern fire conditions seem to necessitate the erection of small traverses and parados in much greater numbers and to a much greater extent than (except in one instance) has been the practice hitherto.

This idea is in no way original, as Colonel J. F. Lewis, R.E., in *Fortification for English Engineers*, published by the R.E. Institute in 1890, in criticising the design of the above-mentioned redoubt, says on p. 34 :—"The weak part of the design is the absence of any protection for the men at the parapet against high angle fire from howitzers or rifled mortars. Light traverses, which would check the dispersion of fragments from shells filled with high explosives, could be easily added." It is thus evident that the question of traverses or no traverses is a vexed one. But before going into the reasons why light traverses are absolutely necessary, it may be stated that in 1890 the effects of high explosive shells against earthworks appear to have been much overrated. The experience of the Boer War seems to point to the fact that men behind properly constructed earthworks are as safe from the effects of high explosives as human methods can make them; and that to obtain their full effects high explosives require to be discharged from a high velocity gun and to have a hard unyielding and upstanding target. Now properly constructed earthworks will never fulfil these latter conditions.

What then, mainly, are the weapons of which the effects must be

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feared by a rifleman? The shrapnel and rifle bullet. In what way will these missiles approach him, and where can we find a parallel in the past to these modern conditions? Take any part of a modern defensive position when under fire, whether part of a temporary or of a permanent line. How is it attacked? Mainly by shrapnel and rifle fire, the rifle bullets from any range up to 2,000 yards, and possibly even over that, and shrapnel from any range up to 6,000 yards and perhaps over. Now these ranges admit of a wide choice of position and fire on the part of the attacker. He can fire from almost every direction, and, whether unconsciously or by design, may be at the same moment firing directly at one portion of the defensive line as well as enfilading another, even taking it practically in reverse, and this from almost every conceivable range within the limits stated; so that his bullets arrive at the defensive position at almost every conceivable angle of direction and drop.

Now where in the past could men be found in such evil case as riflemen in the defence to-day? There is only one example that comes to mind: the Sapper excavating the approach towards the salient of the covered way between the third parallel and the "crowning." He too was exposed to fire from the front, from the flanks, and possibly from the rear? How did he protect himself? By excavating a cube or rectangular sap. What was the essential nature of this form of sap? It was a trench provided with traverses and parados. This gives us a guide as to the form our trenches and parapets should take to-day.

The accompanying sketches indicate a form which the alterations to modern defensive works might take. In *Fig.* 1 the parapet with traverses and parados has been freely applied to the five front faces of the redoubt in *Plate* VII. of *Fortification for English Engineers*, and also to a certain extent to the flanks. In *Fig.* 3 the same method has been applied to a modified extent to the front faces of *Plate* IV. of the same book. The guiding principles adopted in the sketch proposals are :—

1. That there should be a minimum length of 30 ft. parapet between traverses, and that, if possible, the maximum length should not be more than 60 ft., thus giving five to ten rifles to a section of parapet.

2. That the trench, in which the men lining the parapet sit during a heavy bombardment or rifle fire, should not be more than 2 ft. 6 inches wide at the top, thus ensuring that men sitting down would practically be safe against shrapnel fire.

3. That the parapet should be 2 ft. 6 inches thick as a minimum at the sill of the loopholes, and that the tops of the traverses and parados should have a minimum thickness of 2 ft. 6 inches. This thickness is the minimum that will stop a rifle bullet at short range; it is sufficiently thick to stop a shrapnel bullet, and would also stop a good many shell splinters.

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The objections that can be urged against this form of parapet can probably be foreseen. They are :—

1. That communication in such narrow trenches is difficult.

2. That fire control will be impossible with a parapet so cut up by traverses.

3. That both traverses and parados are too flimsy.

4. That machine guns cannot be worked from this form of parapet.

5. That sunk parapets would be difficult to construct and maintain in peace time without concrete revetments, and that concrete revetments are objectionable on account of the rebound from them of bullets and splinters.

6. That there is no overhead cover.

These objections are met to a certain extent by the following :—

1. The provision of numerous flights of steps or ramps from the main road of the fort or redoubt into the trench forming the rifle parapet.

2. The parapet is divided into convenient lengths for control by one non-commissioned officer.

3. The minimum thickness to resist modern rifle fire is given ; more need not be attempted, as a heavy shell will deform any description of parapet. Thicker traverses would take up too much room in the parapet, and thicker parados too much depth, thereby increasing the target supplied by the fort to the enemy's guns. However, there is no reason why the exact form of traversing shown should be adopted : *e.g.* on the faces of the redoubt in *Fig.* 1 the position of the parapet between two traverses might run on the alignment formed by the two rear ends of the traverses, the parapet being loopholed in the usual manner ; this does not apply to the portion of parapet at the salients.

4. The parapet at the sill of the loopholes is so thin that a few strokes of a shovel would quickly clear away sufficient space to work a machine gun on a tripod mounting.

5. This is perhaps the most serious objection of all. Concrete revetments for the trench must not be used. Probably the best solution would be a suitable corrugated-iron and timber revetment, which might be kept in store in peace time and put in place on a declaration of war or when relations became strained. If not kept in store the cost of maintenance would probably be considerable. There is not the same objection to corrugated iron as there is to concrete ; a bullet or shrapnel ball will not glance off corrugated iron, but will as a rule penetrate and lodge in the earth behind it, and in this case the corrugated iron is backed by earth.

6. In this form of narrow trench overhead cover can easily be improvised.

If corrugated iron and timber is kept in store for the revetments it would be just as well to increase the storage accommodation and

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keep loopholes in store as well. A suitable pattern of sheet-iron box loophole would save much time if the parapet had to be quickly prepared for use, and would not seriously deteriorate in store as sandbags frequently do.

The siege of Port Arthur seems to point to the fact that electric light projectors are an indispensable part of the furniture of a modern fortress. Two to each fort or permanent redoubt would seem to be necessary. It does not seem advisable to provide permanent emplacements for these; for it is conceivable that they might both be required on the same side of the fort or redoubt, and the leads can be taken anywhere. The engines to work the projectors might be accommodated in the central casemates. When a siege has progressed somewhat a suitable place for a projector could easily be obtained by modifying a gun emplacement, it being presumed that during the middle period of a siege the guns would be removed from the forts to batteries outside.

This latter point brings us to the very vexed question as to whether guns should be placed in forts at all, and if so, what guns. On the whole it seems best to place a few powerful guns in the forts, on travelling or movable carriages so that they can be placed in the intervals after the main attack of the besieger has developed. The reason for this is that permanent fortification must be considered from a political as well as a military point of view. If no gun emplacements were provided in the forts it is conceivable that a Government in a fit of economy might omit to provide the fortress with any guns at all; whereas if emplacements were provided in the forts, and it came to be known that they were unarmed, the newspapers would probably make such an outcry that the Government would be compelled to provide sufficient armament for those emplacements at least, and thereby a certain number of guns for the fortress. From this point of view four guns per fort would not seem an overwhelming armament.

Probably the heaviest gun that can be easily obtained in any number is the 4·7″ Q.F. The Admiralty are practically abolishing this gun in the Navy; so that a large number of this class should be easily obtainable; after providing for the requirements of our coast-batteries probably a sufficient number would be left over for our important land fortresses. The trend that Naval construction is now taking seems to point to the probability of a large number of 6″ Q.F. guns being available for land works at no very distant date. If this prove to be the case, it might be advisable to mount these in our detached forts on fairly mobile carriages. There is, however, one advantage in employing the 4·7″ Q.F. gun; and this is that we have already in the Army several heavy field batteries armed with this pattern of gun, so that there must now be a considerable number of men trained to its use; as a

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rule, for guns of the same date, the heavier the gun the more complicated its mechanism.

Having considered the nature of the guns to be mounted it is necessary to refer for a moment to the method of mounting them. Let us presume, for the purposes of this article, that they are on some form of travelling carriage and have to be moved about; and that the conditions of efficient service do not allow of their being mounted on an overbank carriage, but that, being Q.F. guns, the carriages have little or no recoil. If the above presumptions are correct it would probably be possible to place the gun and carriage on some kind of concrete drum, with the numbers working the gun standing at a lower level, so that only the gun layer is exposed. If the emplacements shown in *Fig.* 3 are not large enough to admit of this they could probably be easily modified to the necessary extent.

Now comes the question as to whether it is advisable to mount the guns on the front faces of the fort at all. On looking at the front faces of *Fig.* 3 it becomes evident that the gun emplacements with their traverses and ramps take up a huge proportion of the interior of the fort and of the length of parapet. It is conceivable that it might be better to mount the guns on the central and rear casemates and to make the main parapet similar to that in *Fig.* 1. If this were done some other means than ramps must be provided for moving the guns. Colonel Lewis anticipates this proposal on p. 101 of *Fortification for English Engineers*, where he says:—"The easiest way to attain it sometimes is to have an opening in the floor of a bombproof and to hoist the guns up vertically." The simplest solution of the problem would be to provide hydraulic or electric lifts, similar to those used in large railway stations for moving luggage from a platform on a low level to one on a higher. On these lifts the gun and carriage, together or separately, could be lowered to the casemates beneath and to the general level of the main communications of the fort. The present writer has hesitated to indicate on the sketches such a method as this, as he does not possess sufficient data to work out the form and size of the lift or even to make certain whether such a method would be practicable. The weight to be moved, however, does not seem to be so very excessive, about 4 tons in the case of the 4·7″ Q.F.; and the space required for the lift in plan would seem to be about 16′ × 6′, say 100 sq. ft., which is considerably less than that occupied by a ramp.

If lifts are ever adopted the power for working them must be considered. If projectors are provided for the forts there would be little difficulty about this; the dynamos being connected up with the necessary motors when required for the lifts, a switch at each lift, and the necessary leads would seem to be all the accessories required; while accumulators might be added to work a system of incandescent lighting throughout the fort. If the gun emplacements were placed

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on the front faces it is conceivable that they might be used as a rapid method of getting riflemen on to the front parapet in case of a sudden dash on the part of the besiegers; in place of the road in rear of the front parapet a casemated passage might be employed, which would greatly add to the security of the defenders.

Leaving the question of lifts and armament let us again return to more actual facts. One advantage of the form of parapet proposed has not yet been brought out, that is its use during the closer stages of a siege. The Royal Military Academy *Text Book of Fortification*, Vol. I., published about 1880, says :—"Use should be made of counter-approaches. They are made towards the front to furnish a close fire upon the heads of the approaches . . . or pushed out to a flank to enfilade the approaches or take them in reverse." (*Vide* Clamart Station, Siege of Paris, 1870. Viollet Le Duc's *Annals of a Fortress; The Last Siege.*)

As regards secondary armament the writer submits to Colonel Lewis's opinion that tourelles are necessary. The only amendment he would like to make is that 12-prs. should be employed; this would give a gun which, though certainly more expensive, has a muzzle energy of 423 foot-tons as against the 137 foot-tons of the 6-pr.

On looking at *Fig.* 1 it becomes easy to imagine that it might readily occur to the commander of a similar redoubt to break out from the parallel formed by the front parapet, and to make counter-approaches against the besieger wherever necessary over the superior slope of the front parapet; as long as the sunken railing was intact he would know that his sappers could work in perfect security against any rushes from the enemy and that his counter-approaches could not be rushed and seized. There is one objection to this method; it is clearly stated by Sir George Clarke in his above-mentioned book :—"To work on a slope turned towards the enemy is a hazardous operation even by night, while the cessation of the artillery fire of the upper rampart would be further entailed." Sir George Clarke refers to one of General Brialmont's forts after the parapet has been deformed by heavy artillery fire, so that the case is not exactly parallel; but this objection has such weight that it is necessary to consider how it can be met. There are two answers to the objection just as there are two parts to the above quotation. The first is that the superior slope must be very flat, about $\frac{1}{15}$ as a maximum, when the objection ceases to have very serious weight; secondly, if the guns have been removed from the forts, there can be no interference with the artillery fire of the upper rampart. While considering for a moment this question of counter-approaches, for which it is urged every provision should be made in a modern fortress, it becomes evident that the usual recommendation*—"the glacis should be

* Sir George S. Clarke's *Fortification*, etc.

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planted with trees, whose roots when the trees are felled would prevent Sapping"—can only be accepted with the reservation that trees should not be planted closer to the crest of the glacis than 100 to 150 yards; otherwise possible counter-approaches would be interfered with. Counter-approaches, however, seem only possible when the slope of glacis is very flat, so that each case must be considered on its own merits.

These considerations have now led up to a point where it may be asked:—What would an ideal modern detached fort be like? If our premises are correct, our conclusions and their requirements would appear to be somewhat as follows (*Figs.* 6 and 7):—

1. A ring of obstacles with a covered way in front of it; whether the obstacle should be a deep ditch well flanked or a covered railing would seem to be a matter of opinion or expense. Port Arthur seems to point to a deep ditch being necessary in order to force the besieger to mine; this, however, seems unnecessary in England, though it might be advisable in the Colonies.

2. Presuming that a covered railing is adopted, the second requirement becomes a steepish exterior slope, rising at $\frac{1}{3}$ from the covered railing to about the level of the top of the railing, and forming a position defending the ditch.

3. A rounded mound of suitable earth, rising in flat slopes of not more than $\frac{1}{15}$ from the ditch parapet, forming a position for riflemen for the close defence of the position. In this mound suitable trenches might be dug previous to the siege along the line of the probable front faces required, and positions might be prepared for field guns; or the preparation of the necessary trenches might be postponed until the declaration of war. But in the mound must be provided sufficient casemates for storage and for the garrison in time of war. Behind the mound must run a sunken roadway for communications or a suitable casemated passage with communications to the trenches.

4. Behind the mound again, or included in it, must be emplacements for guns of position, with means (lifts or ramps) of removing them to outside the fort.

5. Dynamo and accumulator room to provide the necessary power for working the projectors, incandescent lights, and lifts.

The writer has neither the data nor the time available to draw the plan of such an ideal fort. Moreover there are many objections to the proposal contained in the above five headings. Three seem almost insuperable, viz.:—

1. The resulting plan would be so deep from front to rear that the fort would cover an enormous area and would therefore present a very deep target to the enemy.

2. The ring of obstacle required to enclose such a work would be very long and therefore very costly.

3. The form of design proposed would only be suitable to very flat

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sites or at any rate to gently undulating country. It would be impossible, for instance, to occupy a steep narrow ridge in this fashion. *Fig.* 7, however, gives some general indication of the form that the work might take.

Nothing up to the present has been said in this article regarding coast fortification. There is one conclusion, however, to be drawn from the attempts of the Japanese to "bottle up" Port Arthur, namely :—that a power having command of the sea would be willing to sacrifice ships of no great value in order to enable torpedo craft to attack ships lying in a harbour with a narrow mouth protected by a boom. The ship or ships employed on such a service would probably be old merchant ships of sufficient size to smash boom defences even when travelling at slow rates of speed. The very size of such ships would be a protection to them against the fire of the smaller fortress guns, and it becomes necessary to consider whether each boom defence should not have a battery or batteries of two or more 6-inch guns sited to seaward of the boom and firing over the "lighted area." The 6-inch is the smallest gun that can be depended on for such work and its rate of fire is such that it should be able to accomplish its object in the short time available.

The objection to the above proposal is that the guns, by sinking the attacking vessel, might merely be accomplishing a secondary object of the enemy, namely :—To block the harbour mouth. The answer to the objection is that no attempt to "bottle up" a harbour has succeeded as yet, and with powerful dredgers available an alternative channel might be quickly dredged, or the obstruction removed by explosives.

To those acquainted with our coast defences, several instances will occur where the 6-inch boom batteries advocated might be adopted with advantage.

In conclusion the writer would beg to state that, if any of the ideas here put forward have previously appeared elsewhere than as noted in the text, he is not aware of it and apologises for his unconscious plagiarism. He also desires to thank the R.E. Institute for permission to make use of the plans published in Colonel Lewis's book.

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THE ENGINEERS OF THE GERMAN ARMY.

By Col. J. A. Ferrier, d.s.o., R.E.

The technical duties of the German Army are carried out by :—

I. The Chief of the Corps of Engineers and Pioneers and Inspector-General of Fortresses, who has under him

A. (i.). The Corps of Engineers, composed of officers only ; and their subordinate establishment
(ii.). The Corps of Fortress Constructors.
B. The Corps of Pioneers.

II. The Inspector of Communication Troops, who has under him

A. Railway Troops.
B. Telegraph Troops.
C. Balloon Troops.

III. Other cognate duties which we are accustomed to view as Engineer services are carried out as follows : —

A. Barracks and Military buildings, not included under the designation "Fortifications," by the Garrison Bauwesen (Barrack Construction Department), a branch of the Intendantur.
B. Search Lights—By the Corps of Fortress Constructors.
C. Survey—By the General Staff.
D. Submarine Mining—By the Navy.

I. A. (i.). THE CORPS OF ENGINEERS.

The Corps under headings A (i.), A (ii.), and B are distinct as regards duties, although under one Chief.

Duties. The duties of the Corps of Engineers are :—Construction and care of fortifications, fortress telegraph systems, electric lights, pigeon post, and other fortress services ; custody of the demolition chambers in bridges and tunnels.

Officers. The officers are allotted to the various fortresses and are expected to be acquainted with every detail of the defences and the surrounding country.

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Members for Technical Committees and Instructional Establishments are also drawn from the Corps.

Engineer Inspections.

There are 4 Prussian* and 1 Bavarian Engineer Inspections, controlled by Major-Generals assisted by 2 Adjutants. The Prussian are further divided into 9 Fortress Inspections, controlled by Colonels or Lieut.-Colonels assisted by 1 Adjutant.

War Employment.

In war the officers would be employed in sieges and in defence of fortresses (see later on).

ESTABLISHMENT OF OFFICERS.

The Army Estimates for 1905 provide for the following:—

Prussia.

1	Chief of Engineers.
4	Engineer Inspectors.
3	Pioneer Inspectors.
1	President Engineer Committee.
9	Fortress Inspectors.
3	Regimental Commanders and Staff (or Field) Officers in like rank.
3	Chiefs of Divisions in Engineer Committee.
1	Chief Staff Officer of the General Inspection of Engineers, Pioneer Corps, and Fortresses.
67	Field Officers.
88	Captains 1st Class.
63	Captains 2nd Class.
145	Senior Lieutenants.
239	Lieutenants.
40	Junior Lieutenants.
Total 667	

Saxony.

1	Commander of Pioneers.
3	Staff (or Field) Officers.
6	Captains 1st Class.
5	Captains 2nd Class.
8	Senior Lieutenants.
21	Lieutenants.
6	Junior Lieutenants.
Total 50	

* NOTE.—Including Saxony and Würtemberg, except where otherwise stated.

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Würtemberg.

1 Staff (or Field) Officer.
3 Captains 1st Class.
2 Captains 2nd Class.
4 Senior Lieutenants.
12 Lieutenants.
2 Junior Lieutenants.

Total 24

Bavaria.

The Estimates are not available, but the Army List of 1905 shews under "Inspection of Engineer Corps and Fortifications; Münich,"

1 Chief of Engineer Corps and Inspector of Fortifications.
2 Adjutants.
and under "Chiefs of Districts (Abteilungs Chefs),"
3 Colonels.
1 Captain.
1 Senior Lieutenant.
1 Lieutenant.

Total 9 (and 1 Head Foreman of Works at H.Q.).

The following para. is then inserted:—"Under the Inspector of Engineer Corps and Fortifications come:—The Pioneer Battalions, Railway Battalion, Telegraph Companies with Cavalry Telegraph School, and the Balloon Detachment, in their personal and technical aspects; the Fortresses."

The 3 Pioneer Battalions have the following officers:—

	No. 1. (Ingoldstadt).	No. 2. (Speyer).	No. 3. (Münich).	Totals.
Staff or Field Officer (C.O.) ...	1	1	1	3
Captains	5	4	3	12
Senior Lieutenants	3	3	1	7
Lieutenants	13	13	7	33
Totals ...	22	21	12	55

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From the above we have in the whole Army, in peace time, as officers of Corps of Engineers and Pioneers

Prussia	667
Saxony	50
Würtemberg	24
Bavaria	64
Total	805

It is convenient to treat the officers of the Engineer and Pioneer Corps together as they are so shewn in the estimates. They appear to belong to one list for promotion, and to be interchangeable in the sense that an officer of Pioneers may be transferred to an Engineer Inspection and *vice versâ*. They enter the service under the same system and their preliminary training is identical. It is in their employment only that they differ; for Pioneers have no share in purely Engineer services, in spite of the fact that, in the regulations for the attack of fortresses, the Commanding Engineer and Commanding Pioneer Generals appear to be interchangeable.

The number of officers serving at any moment with the Pioneers is very difficult to determine with any accuracy. They vary enormously from year to year, and so it is almost impossible to arrive at the exact number of officers employed on purely Engineer Corps duties.

Taking the figures for 1904, we find

Prussia and Würtemberg.

514 Pioneers.
202 Engineers.

Saxony.

46 Pioneers.
7 Communication Troops.
3 Staff and Expeditions.

Bavaria.

59 Pioneers.
22 Communication Troops.
36 Engineers.

For 1905 the numbers for Prussia, Würtemberg, and Saxony are approximately the same; those for Bavaria are considerably reduced, as there are only 64 officers altogether, of whom 55 are serving with Pioneers.

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OFFICERS' COMMISSIONS.

The Officers enter the Army in the same way as all other officers; they need not necessarily begin their service as Engineer Officers, but can come from some other unit if they pass the necessary examination in going through the new Technical War Academy.

Avantageurs. The usual way is through the ranks. A Candidate, having obtained a 2nd Class Certificate at school, joins a regiment, with permission of the Colonel, as a One-year Volunteer, and is generally known as an Avantageur. For 6 weeks he has to live in the barrack room; after this he is allowed to live out, to mess with the officers, and to wear clothes of superior cloth at his own expense and an officer's great-coat when not on duty. After 5 months' service he passes an examination in military duties, and is nominated Fähnrich. In this grade he serves at least 6 months, thus doing 11 months in the ranks. He then goes to a War School, a kind of Garrison Class, to prepare for the Officers' Examination. Finally he is "chosen," *i.e.*, elected as a brother officer by the regiment in which he wishes to serve; and, after passing the Officers' Examination, is appointed 2nd Lieutenant.

Cadets. Candidates from the Cadet Schools (where, by the way, military subjects are not taught) usually join a regiment from the 2nd Class; and are treated exactly like the One-year Volunteers, except that they join as Brevet Fähnrich and are exempt from the 6 weeks in the barrack room. A small number of Cadets, who remain an extra year at the Chief Cadet Establishment, are appointed direct without passing through the ranks, and go straight to the War School. Selected very brilliant Cadets are promoted from the 2nd Class to the Selected Class, and after one year in it join as 2nd Lieutenants. Candidates who have been one year at an University are allowed to join as Avantageurs, and to pass the Officers' Examination at the end of 6 months' service in the ranks.

Artillery and Engineer School. Engineer and Pioneer Officers are nominated Supernumerary Second Lieutenants and serve as such for $1\frac{3}{4}$ years, at the end of which time they proceed to the Artillery and Engineer School for $20\frac{1}{2}$ months. In the first year they do 2 days' fortification exercises, in the second year 2 days' practical fortification on the ground; the rest of the fortification work is theoretical. On passing the final examination the students rejoin as Second Lieutenants.

It is believed, though no details are to hand, that the experiment is being tried of training young officers for the Engineer Corps, and possibly also Pioneers, at Berlin University (Hoch Schule) instead of at the Artillery and Engineer School.

Technical War Academy. As already mentioned, officers of other arms can pass through the Technical War Academy and become Engineer Officers.

It appears from an article in the *Kriegstechnische Zeitschrift*, reviewed in *R.E. Journal* of April, 1905, that the course is specially

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designed to enable officers of the Verkehrstruppen (Communication Troops to be hereafter described), of the Technical Staffs and Establishments (*e.g.* gun, rifle, and ammunition factories), and others who wish to prepare themselves for employment in the Engineer Corps, to obtain such instruction of a scientific and technical nature as is required for military purposes. The subjects of the very comprehensive course are enumerated in the above-mentioned review. They appear to embrace those in our courses at the Royal Military Academy, School of Military Engineering, Artillery College, Staff College, and Schools of Ballooning and Signalling. But Civil Engineering, as such, and building construction and estimating, except as applied to fortresses, appear to be excluded.

There is no equipment particular to the Engineers beyond what is in use in the fortresses. Equipment.

All officers are mounted. Mounted Officers.

TRAINING OF OFFICERS.

This will be dealt with under "Organization of Pioneers." It will be observed that it has been necessary to treat of the Pioneer Officers in describing the Engineers, for both receive their preliminary training in the same way and it seems difficult to divorce them. Beyond the training obtained in the Pioneer Regiment or other unit, the War School, Technical Academy, Artillery and Engineer School, or University, there does not appear to be any special annual training for Engineer Officers ; nor is it certain that they take part in the Annual Pioneer Training or Annual Manœuvres as such. But, as will be seen later, Pioneer Officers are annually occupied in training their men with very meagre assistance from N.C.O.'s (who, according to our ideas, serve a very short period), and so are constantly perfecting their knowledge up to a certain point, but mostly in details.

EMPLOYMENT OF OFFICERS (ENGINEERS ONLY).

On the Fortifications ; as Instructors at various Military Educational Establishments ; on experimental commissions. Peace.

The Handbook (*Taschenbuch für den Pionieroffizier, 1904*) says, in Section VIII., "Fortress Warfare" :— War.

Attack.—Attached to the Staff—General of Engineers or Pioneer Corps, for assistance in all questions regarding fortification and the close attack. Draws up projects for distribution and employment of the Pioneers and Pioneer Siege Troops ; has special care to the tactical cohesion of the siege works of the Infantry and Pioneers ; keeps the Commander-in-Chief constantly *au courant* regarding the condition and resisting capabilities of the works and defensive localities of the Fortress ; can demand direct from the Commanding Officers of Pioneers, in the various sections of the attack, reports on the progress

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of the works, materials in the parks, the position of affairs, and information in general; and arranges supplementary supplies of siege material for the Pioneers.

* * * * *

Defence.—The Commanding Engineer assists the Governor in all fortification and technical matters; is responsible to him that the Fortress is brought to the highest development of defensive power, and maintained in that condition, and that the whole technical resources of the fortress are utilized in the best possible way; keeps intimate touch with Commanders of Sections of the defence, and can demand direct assistance from the Engineer Officers of Sections; proposes to the Governor the allotment of Engineer Officers and technical troops to the Sections; arranges the assignment and distribution of the working parties, civil labour, field park, etc.; directs the fortification works, including extensions of the interior communications and high roads, until such time as the Section Commanders assume responsibility for the same within their sections; exclusively controls, from the moment they are enrolled, the progress of the fortification civil workmen; arranges any necessary departures from the scheme of the defence works, and authorizes any necessary modification of the scale of labour; arranges the network of armament tram lines, works out the traffic management with the Commanding Officer of Artillery, controls the traffic, and has authority to allot, if necessary, certain sections for particular purposes (connections of service lines to batteries, etc., and their working is the business of the Garrison Artillery); erects, maintains, and works the Fortress telegraph system.

I. A. (ii.). THE CORPS OF FORTRESS CONSTRUCTORS.

The duties of this Corps are confined to the construction of Permanent Fortifications. Although subject to the Inspections of the Corps of Engineers, the *personnel* come under the jurisdiction of the Invaliden.

ESTABLISHMENT.

The Army Estimates for 1905 provide for the following:—

Prussia.

83	Senior Lieutenants and Lieutenants.	
6	Pensioned Staff Officers at large Fortresses.	
111	Fortress Head Foremen of Works.	
1	Telegraph Foreman.	
48	Fortress Warders.	
206	ditto.	
21	ditto	as Master Collar Makers with Pioneers.

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Saxony.

1 Fortress Head Foreman of Works.
1 Fortress Warder.
2 ditto for Pioneer Battalions.

Würtemberg.

1 Fortress Warder as Master Collar Maker with Pioneers.

Bavaria.

7 Captains.
7 Senior Lieutenants.
2 Lieutenants.
6 Head Foremen of Works (1 at H.Q.).
7 Foremen of Works.

The Corps was constituted by Cabinet order, dated 20th March, 1903. It consists of:—

(i.). Festungs Bau Officieren (Fortress Corps Officers).
(ii.). „ Beamten (F.C. Officials).
(iii.). Wallmeistern (Foremen of Works).

(i.). Are divided into ranks as follows:—

Festungs Bau Hauptleute (Captains).
„ Oberleutnante (Lieutenants).
„ Leutnante (Junior Lieutenants).

They belong to the unattached Active list of Officers of the Peace Establishment.

(ii.). Are divided into:—

Festungs Bau Oberbauwarten (Fortress Head Warders).
Festungs Bauwarten (Fortress Warders).

They belong to the Servisberechtigten Militär Beamten (Covenanted (?) Military Officials), and rank as Officers.

(iii.). The Wallmeister belong to the ranks, with rank of Feldwebel (say, Sergeant-Major).

The Festungs Bau *personnel* are allotted to:—Fortifications; Fort Inspections; Engineer Committee; General Inspection of Engineer and Pioneer Corps; School of Fortress Construction.

The Kingdom of Bavaria has a special F.B. *personnel;* while the officials known as Anwärter (overseers) from Würtemberg and Saxony are taken over by Prussia on nomination to Wallmeister.

RECRUITING AND TRAINING.

The *personnel* is drawn from qualified N.C.O.'s of the Pioneers, who, before appointment as Wallmeister, must undergo a special course of education.

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Winter classes are held in Pioneer Battalions to thoroughly educate young N.C.O.'s in all branches of Pioneer work, theoretical and practical, to revive and keep up their knowledge, and to prepare them for the future position of Officials (Beamte). Diligent N.C.O.'s are encouraged by the promise of official posts in civil life. These classes are the basis on which N.C.O.'s work to qualify for admission to the Festungsbauschule (Fortress Construction School). The subjects treated are :—Duties; practical pioneering; the art of fortifying; German language; military correspondence; writing; cyphering; geometry; geometrical and plan drawing; history; geography; and in some battalions stenography.

Festungsbauschule.

The Festungsbauschule is an independent establishment of the Engineer and Pioneer Corps; its object is to prepare candidates by yearly examination for Fortress Corps Officers.

It is in the Charlottenberg Garrison, and its Director is a Field Officer of the Engineer Corps. It is under the President of the Engineer Committee, under the control of the Inspector-General of Engineers and Pioneer Corps, who chooses the syllabus and orders books and instructional material. Its administration is subordinate to the Prussian War Ministry.

Nominees are N.C.O.'s of unexceptionable character of from 5 to 6 years' service in the army with a minimum of 3 years as N.C.O. Exceptions are made for one-year volunteers who have passed through Technical Schools. The Course lasts 1 year 9½ months, and includes free gymnastics and use of weapons; 27 days' leave per annum are allowed. Examinations are held every quarter, and there are two yearly entrance examinations, written and *vivâ voce*. Failure means return to the unit for 1 year, after which a second and last chance is given.

EMPLOYMENT.

Peace.—On Fortification work, generally. At Headquarters with the Engineer Committee, Technical School, or like Establishments, or in the Verwaltungs Schirrhof (a large central store or park in which books and ledgers are kept by the nominees).

Independent Forts are the most popular service. The duties comprise electrical works, fortress telegraphs, and pigeon post.*

War.—The Corps generally remain in their fortresses, except some officers and foremen of works who take the field with Siege Corps and work search lights. The *personnel* on declaration of war is at the disposal of the I.G. of Engineer and Pioneer Corps, and can be ordered abroad.

* But the Pigeon Post Wallmeister are not required to pass through the Fortress Construction School.

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I. B. THE CORPS OF PIONEERS.

ORGANIZATION.

There are 26 *Pioneer Battalions in the 4 Prussian and 1 Bavarian Engineer Inspections (Technical) under the Inspector-General of Engineers and Pioneers, who is assisted by 4 Engineer and 3 Pioneer Inspectors as his agents. The battalions each have 4 companies in peace; they are distributed in Table I.

Second Line Troops.

A Reserve Pioneer Field Company, with Reserve Divisional Bridge Train attached, will be provided for each Reserve Division. The number of Reserve Divisions would probably be 2 in each Army Corps District of 2-Division Corps and 3 in the Districts of 3-Division Corps (viz., I. and XIV.).

The Depôt Companies will probably number 26, one per battalion; but it is not absolutely certain that more than 20 are at present organized. Each is formed from 50 Ersatz† Reservists, Active Reservists, and Landwehr men as required.

The Landwehr Pioneers will form 60 Fortress Pioneer Companies.

The total available Pioneer Troops may be put in round numbers at 1,180 officers and 54,000 rank and file.

Each Army Corps has one Pioneer Battalion, except the I., XV., and XVI. Corps, which have two.

War Formation.

On mobilization each Pioneer Battalion forms:—

(*a*). A Battalion Staff, which joins the staff of the G.O.C. Army Corps.

(*b*). Three Pioneer Companies, one being permanently attached to each Division, and the third kept at the disposal of the A.C. Commander.

(*c*). Two Divisional Bridge Trains, one attached to each Divisional Pioneer Company.

(*d*). One Corps Bridge Train, with a special detachment of Pioneers.

(*e*). Two Siege Companies.

The details of units are shown in Tables II. and III.

The 1st and 14th Battalions will probably each mobilize 4 Pioneer Companies and 3 Divisional Bridge Trains, as the Army Corps to which they belong have each 3 Divisions. Certain other battalions, probably 11, will mobilize detachments of Pioneers to accompany the Cavalry Divisions. On the other hand the 18th, 19th and 20th Battalions would probably be employed as Fortress Pioneers in their respective

* Viz. 20 Prussian, 2 Saxon, 1 Würtemburg, and 3 Bavarian.

† Composed of supernumeraries not taken for the annual contingent, men excused service for family reasons, minor bodily defects, temporarily unfit likely to recover. The first category has almost died out owing to full annual contingents being absorbed.

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fortresses (Table I.), mobilizing 8 Siege Companies each. The total number of field units mobilized would, therefore, be :

23 Staffs.
71 Field Companies.
48 Divisional Bridge Trains.
23 Corps Bridge Trains, with Pioneer detachments.
70 Siege Companies.
11 Pioneer detachments for Cavalry Divisions.

PIONEER COMPANIES.

Arms. Officers, Medical Officers, Officials, Sergeant-Majors, vice-Sergeant-Majors, and Ensigns are armed with swords and pistols (revolvers or repeaters) ; buglers with sword bayonets and revolvers ; officers' servants and hospital assistants with sword bayonets only ; transport (Train) drivers with O.P. cavalry swords only ; other ranks with 1888 and 1898 pattern rifles and sword bayonets with saw backs.

Personal* Equipment. Belts and straps are of black leather. Kits are carried in cowhide knapsacks, supported by braces attached to the waistbelt. Inside the knapsack is a bag for reserve rations, which can be carried separately if knapsacks are left behind. On the waistbelt, on each side of the buckle in front, is a pouch for 45 rounds, and 30 more are carried in the reserve ration bag. A haversack, light-brown, is looped on to the belt on the right side ; in rear is the oval aluminium water bottle, covered with grey felt and provided with cup ; on the left side are carried the sword bayonet and also the head of an entrenching (or other) tool, in leather pocket, the handle sticking up alongside the knapsack to which it is strapped. Each man also carries a portion of a tent,† consisting of a canvas square with eyeletted edges, a pole in 3 pieces, 3 tent pegs, and a cord ; the canvas square is rolled and strapped on to the knapsack, which it envelops on the top and two sides. The mess tin is strapped on the back of the knapsack at top. The whole equipment, put together, can be taken off and on like a coat. The total weight, including arms, carried in F.S.M.O. by a man of medium height is about 59 lbs.

Tools. The portable tools carried by each company comprise 88 large shovels, 44 pickaxes, 45 axes, and 18 hatchets. Table IV. gives the tools carried in the wagons.

* For uniform, see Appendix.

† Two men can make an inverted **V** tent ; other combinations can be made by larger numbers. The canvas square can be formed into a float to carry a man's equipment, by connecting opposite corners and stuffing the envelope thus made with straw, etc. ; several combined can be made into a raft, and so on.

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The horses and drivers for the Company Transport are furnished by the Train. Transport.

The four carriages are a 2-horse baggage wagon, a 2-horse provision wagon, a 4-horse tool wagon, and a 4-horse wagon for explosives. There is 1 pack horse.

DIVISIONAL BRIDGE TRAIN (PRUSSIAN).

This Bridge Train is divided into two sections. The first has 1 trestle wagon, 1 pontoon wagon with chock baulks, 2 pontoon wagons with baulks, all 6-horsed; 1 tool wagon and 2 store wagons, 4-horsed. The second section has 1 trestle wagon, 1 pontoon wagon with chock baulks, 2 pontoon wagons with baulks, all 6-horsed; 1 supply wagon and 1 store wagon, 4-horsed. Reserve, 1 baggage cart, 2-horsed. Transport.

The 53 N.C.Os. and men and 87 horses are provided by the Train.

One of the 2 Lieutenants is with the Reserve.

In addition to the above Train *personnel* are, of course, the Pioneer detachment detailed in Table III.

The length of bridge carried is 120 feet, of normal (*i.e.*, 9 ft.) width. The contents of wagons are given in Table IV. For further details as to pontooning see below, page 46.

March orders prescribe the position of the Divisional Bridge Train. If its use is expected it is attached to the Advance Guard Pioneer Company, otherwise it is told off to march with the Heavy Baggage or even with the Train. Certain wagons, as required according to circumstances, can remain with the Pioneer Company. The order of wagons on the march depends on their prospective use.

The C.O. of the Company to which the Divisional Bridge Train is attached is officer commanding the whole, but when the Train is separate the Senior Train Officer commands it.

The Senior Train Officer deals with all interior details and economy of the Train *personnel*, being responsible for the same to the Company Commander. He has the powers of a Company Commander regarding disciplinary punishment of the Train rank and file; if detached at some distance from the Company he exercises these powers also with regard to the attached Pioneer detachment (Table II.). He employs the Junior Train Officer as his subaltern. He is responsible for the training, etc., of the Train rank and file, and for the condition of horses, clothing, equipment, harness, stable gear (renewals must have concurrence of Pioneer Company Commander); he disburses pay, arranges rations and quartering of Train rank and file, feeding of horses, and representation of complaints, and keeps up the war diary.

Higher disciplinary punishments and first court of appeal are vested in the Officer Commanding Pioneer Battalion with the Army Corps.

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In the Reserve Division this function falls to the Divisional Commander. But in all cases the Divisional Commander is the supreme court of appeal.

Equipment. The belts and straps are white for mounted, black for dismounted men, except in the 12th, 13th, 19th, and 25th Battalions, where they are black for all.

Kits for mounted N.C.O.'s and men are carried in two roomy wallets; corn sack and rolled cloak strapped behind the saddle.

Dismounted men in peace carry their own knapsacks; in war they are carried on the wagons; mess tin strapped to rolled great coat, in a fold of which is placed the forage cap. The tent equipment is packed in sacks and carried on the wagons.

Arms. N.C.O.'s, mounted lance-corporals, trumpeters, artificers, workmen, and spare drivers are armed with cavalry carbines (1888) or (in Bavaria) with revolvers, but other ranks have no firearms. All mounted men have an O.P. cavalry sword and dismounted men an O.P. infantry sword bayonet.

CORPS BRIDGE TRAIN (PRUSSIAN).

This is composed of a detachment of Pioneers (2 Officers, 7 N.C.Os., 1 Trumpeter, 53 Pioneers, 1 Hospital Attendant, 2 Batmen, 2 riding horses) and two Half Columns, to the first of which is attached the Reserve.

I. HALF COLUMN.

No. 1 Section.

1 Lieutenant.
27 R. and F.
50 horses.
1 trestle wagon
1 pontoon wagon with chock baulks } 6-horse.
5 pontoon wagons with baulks
1 supply wagon, 4-horse.

No. 2 Section.

26 R. and F.
49 horses.
7 pontoon wagons with baulks, 6-horse.
1 tool wagon, 4-horse.

Reserve.

1 C.O.
1 M.O.
1 Paymaster.
1 V.O.
23 R. and F.
23 horses.
1 demolition (explosives) wagon, 6-horse.
1 baggage wagon, 2-horse.

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II. HALF COLUMN.

No. 3 *Section.*

1 Lieutenant.
28 R. and F.
51 horses.
1 trestle wagon
1 pontoon wagon with chock baulks } 6-horse.
5 pontoon wagons with baulks
1 supply wagon, 4-horse.

No. 4 *Section.*

26 R. and F.
49 horses.
7 pontoon wagons with baulks, 6-horse.
1 tool wagon.

The length of bridge carried (26 pontoons, 6 trestles) is 431 feet as a maximum, but normally 397 feet.

The Corps Bridge Train is an independent command. The C.O. has the disciplinary powers of a detached Captain of Train: the senior officer of the Pioneer detachment those of a Company Commander. The Commandant of Train has the disciplinary powers and exercises the court of appeal of an independent battalion commander. The General Commanding is the highest court of appeal.

The G.O.C. determines the situation of the Bridge Train or its headquarters are settled by its employment. When it is in actual use the C.O. of the Bridge Train has to conform to the requirements of the Pioneer Officer in charge of the Bridge Construction, without regard to seniority.

Personal equipment, kits, and armament are the same as for Divisional Bridge Train.

HEAVY RHINE BRIDGE TRAIN.

In addition to the above is this following special unit. The wagons comprise 96 pontoon, 10 trestle, 4 shore bay, 2 anchor, 2 tool, 2 supply, all 4-horse; and 1 baggage wagon, 2-horse. The pontoons (except the anchor boats carried on the shore bay wagons) are half pontoons.

The attendant Pioneer Company consists of 5 officers and 258 R. and F., with 1 field demolition (explosives), 1 baggage, and 1 supply wagons. Length of bridge all in—

48 pontoon bays at 5·75 m. = 276
14 trestle „ at 4·24 m. = 59·36

335·36 m.
or 367 yards nearly.

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OTHER *MATÉRIEL.*

Steel Boat Bridge Train for a Cavalry Regiment.—This consists of two 4-horse wagons, each carrying 2 steel boats and 4 bridge superstructures, 4 m. long, 1 m. wide. From this can be made :—1 raft, 16 square mètres; or 1 footway, 1 m. wide, 20 m. long; or 1 light bridge, 2 m. wide, 12 m. long; or 1 column bridge, 3 m. wide, 8 m. long.

The raft can carry in fine weather :—1 gun with limber and gunners complete for war; or 4 horses with attendants; or 1 troop wagon; or 50 saddles, kits, and equipment of 50 cavalrymen; or 30 infantry in heavy marching order; and proportionately less if weather is bad.

Folding-boat Equipment in place of steel boats. Each regiment has one 6-horse wagon, with 4 half-boats and 4 superstructures.

BAVARIAN WAR BRIDGE TRAIN.

Matériel. Pontoons for bridge are made up of a bow piece and a stern piece connected or of 2 bow pieces with 1 stern piece between. Each bay has 7 chock baulks or 7 shore baulks.

Divisional Bridge Train. The number of carriages in the Divisional Bridge Train is the same as in the Prussian unit, enough for 43·5 m. length of bridge (47½ yards). From this *matériel* can be made :—Footway (3 baulks), 85 m.; light bridge (4 baulks), 60 m.; column bridge (normal), 40·34 m.; ditto (strengthened* for heavy carriages), 30·22 m.; heavy column bridge (infantry crowded), 24 to 26 m.

Corps Bridge Train. The Corps Bridge Train wagons are :—24 6-horse for baulks and trestles and 8 4-horse for pontoons. The tool, store, demolition, and baggage wagons are the same as in the Prussian unit, enough for 166·64 length of bridge (182 yards). The following lengths of bridges can be made :—Footway (3 baulks), 270 m.; light bridge (5 baulks), 165 m.; column bridge (normal), 144·38 m.; ditto (strengthened† for heavy carriages), 82·74 m.; heavy column bridge (infantry crowded), 63 to 83 m.

SIEGE COMPANY.

The Siege Companies are organized like a Pioneer Company, less one 2nd Lieutenant and the Bridge Train; and the personal equipment, kit, and armament are exactly the same. Attached to each Siege Company there is a "Pioneer" Siege Train (equivalent to our R.E. Siege Park), of 4 sections and a reserve. Details of the wagons and their contents are given in Table IV.

No details are to hand of the *personnel* furnished by the Train, but it may be set at approximately 2 Officers, 15 N.C.O.'s, 4 Trumpeters, 2 Shoeing-smiths, and 116 Drivers.

* 72 chesses short for complete strengthened bridge to be double chessed.

† 4 chesses short for double chessing.

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PIONEER DETACHMENT FOR CAVALRY DIVISION.

This consists of 1 Lieutenant, 30 R. and F. Pioneers, 3 Train, with 2 riding horses for the officer and a 4-horse equipment and store wagon.

The men would probably use bicycles or be carried in requisitioned carriages. During manœuvres 2 ladder-sided 2-horse wagons carried a detachment of strength as above. The personal equipment, armament, etc., are the same as for Field Companies. The portable tools comprise 13 large shovels, 6 pickaxes, 8 axes, and 3 hatchets.

RECRUITING AND PAY.

The Pioneers receive their recruits, about 250 per battalion, in November. As far as possible boatmen, carpenters, navvies, raftsmen, etc., are allotted to them after the usual selections have been made for the Guard and Artillery.

Terms of Service.

Service is for 2 years with the Colours, from 20th year of age; 5 years with Reserve; 11 years, approximately, concluding on 31st March of the man's 39th year, in the Landwehr; and the remainder of his service up to end of 45th year of age in the Landsturm 2nd* Levy.

One-Year Volunteers.—Young men who reach a certain standard of education, and who engage to clothe, feed, and equip themselves, obtain the privilege of being transferred to the Reserve at the end of 1 year's service with the Colours, and are called "One-year Volunteers." It is from this category that Avantageurs (see above, I. A (1), under "Officers' Commissions") and the large majority of the Reserve Officers are obtained.

Two, Three, and Four-Year Volunteers.—Men who have completed their 17th year, and are desirous of making the army their profession or of serving in a particular regiment, are permitted to volunteer for a period of 2, 3, or 4 years, after which they may re-engage.

From this category comes the bulk of the non-commissioned officers. Other N.C.O.'s come from the Under Officers' Schools; these men engage to serve 4 years in the Army.

Pay.

There is no Corps pay (or, as we know it, Engineer pay) for officers and rank and file.

The officers are paid at the same rate as those of the Cavalry, Artillery, and Train. A Pioneer private receives 10s. 6d. a month.

* The 1st Levy, intended for home defence but liable on emergency to be called up to fill the Army, is composed of all males (who do not belong to the army or navy) from 17th birthday to 31st March of year in which they complete 39 years of age.

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TRAINING.

An Imperial order lays down that Pioneers, by their training and armament, are as well able as other troops to take their part in actual fighting, although their special duty is the execution of technical works in the presence of the enemy.

The training of the rank and file embraces that of the officers, whose practical work is all assimilated during their period of service in the ranks; their theoretical instruction comes afterwards (see above, I. A (1), under "Training").

From the date of joining, in November, until the end of May the training is that of an infantry soldier. The hours of work are generally 6 to 11 a.m., 2 to 4 p.m., and one hour's theoretical instruction in the evening. In the middle of February the recruits are mixed up with the older soldiers; company and battalion drill are practised, and the musketry course carried out (Pioneers are allowed less ammunition than the infantry); instructional firing is not executed at ranges exceeding 400 mètres. At the end of May the infantry training ceases, except one day's drill a week, and fieldworks are begun. The instructors are the Company Officers.

Field Fortification.

The regulations lay down that each soldier must be practised in all the works of the *Feldbefestigungs Vorschrift* (abbreviated F.B.),* a small book of 84 pages, including plates which are embodied in the text. The instructions it contains are general; for, as usual, much is left to the intelligence and initiative of the officers. A few extracts from the General Observations will suffice to give an idea of the scope.

"(i.). Aim and object of F.F.

"The power of modern firearms has increased the importance of fortifications in the field.

"In season and in the right place they render important, sometimes indispensable, service: while they augment and conserve the fighting power of troops they enable small forces to offer strong resistance or admit of troops being spared to deliver a counterstroke at a decisive point.

"Even on the offensive, localities won can be fortified with advantage.

"(ii.). The C.O. prescribes the use of field defences, so it is necessary they should serve in every case the aims of the leader and not, the other way about, cramp his action. The latter happens when work is begun before the object is determined. Premature fortification of the field of battle is pernicious, for it destroys freedom of movement.

"(iv.). In the close examination of the ground too much importance must not be attributed to isolated imperfections. Weak points in large positions are unavoidable, and must be compensated by stronger dispositions.

* D.V.E. No. 230. Berlin, 1893. Mittler & Sohn, Kochstrasse, 68—70. New edition corrected up to April, 1903.

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"(v.). The position chosen must invariably be judged from the attacker's point of view and, when possible, viewed from the front.

"(vi.). Once the decision to fortify is arrived at, it must be determined whether the decisive battle is to be accepted there or only time to be gained.

"(vii.). Strong obstacles in front invite the enemy to a turning movement and hinder the counterstroke. They can be valuable when the flanks are secure or when the object is to gain time by forcing the enemy to a turning movement.

"(ix.). The first consideration is a free field of fire—(describing it). A cross fire on the probable lines of approach, and the power of unison between infantry and artillery up to the last moment, are most important."

The contents of the book are much the same as practised in any other army from shelter trenches to deep sap. It is laid down that field redoubts are for infantry only, as a rule not less than a company; the trace to be in conformity with the shape of the ground; parapet lowest possible giving command of fire; all sharp angles to be avoided. The type plan is drawn in curves, and a few bombproof and such like covers and traverses on the flanks are indicated. The only dimension given is "about 150 m." for the firing perimeter, *i.e.*, from one inner flank round by the front to the other inner flank.

Siege work is disposed of in 20 paras., 6 pages. One paragraph of 5 lines explains that in Defence "Similar trench work would be used to counter-attack the besiegers." There are no types for siege trenches. Instead of parallels, a series of infantry positions, not necessarily connected together, are prepared. As a rule they are simply improved and widened standing shelter trenches, but may be executed by sapping near the place. Approaches by zigzag are made if necessary. The use of obstacles in front of the infantry fire positions or parallels is recommended. Blindages, constructed of 3-ft. widths of corrugated iron, are much used.

The general opinion in Germany seems to be that artillery will not be able to destroy fortresses; that counterscarps, flanking defences, and obstacles must be destroyed by mining; and therefore that art has come to the front again.

The Courses are divided into 2 sections:— The Courses.

(1). General, the contents of the F.B. text book, carried out by all Pioneers.

(2). Special, (*a*) Pontooning for the men of the Field Companies, (*b*) Mining for the men of the Siege Companies.

The amount of time devoted to each subject is left to the Battalion C.O. Usually 2 months are given to the General Section and 1 month to the Special before the Manœuvres. Every Pioneer is taught to swim.

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Exercises and Manœuvres.—About the end of August there are usually Pioneer exercises on a large scale. A number of Field Companies are collected for bridging operations, and the Siege Companies are employed in conjunction with the Fortress Artillery.

Pontooning.

The text book, *Pontonir-Vorschrift* (abbreviated P.V.), 1902, prescribes fixed words of command for the simplest and ever-recurring practices only; but for everything else merely general indications that must be adapted to circumstances.

Technical pontooning instruction is to be brought to a close by exercises in the most variable circumstances. The training of the "last-joined" in boating and individual details of work must be sufficiently advanced for them to join the Field Company on 1st April and share in the pontooning exercise as helpers and carriers.

Exercises in the familiar surroundings of the training ground are to be supplemented by numerous practices in unknown country with horsed wagons and in combination with other arms. . . . Besides training the senior officers and men these exercises will instil in other arms an understanding of the executive capabilities of the Pioneers.

Superiors, from Company Commanders upwards, are responsible for the training of their subordinates. . . . Those in higher positions of command have to see that all parts of the *P.V.* are gone through in letter and spirit.

The pontoon is built of steel or of wood with steel ribs; it is double stemmed, without sheer; about 7½ m. long, 1½ m. beam, and 1 m. deep; straight sides and round bottom; no keel, but two side bottom strakes and two gunwhale strakes, to which are riveted the hooks for lashing on the baulks. There is no saddle. Near the stern at each end is a stout round thwart, round which a bight of the cable is turned and made fast with a woulding stick. As to weight it can be loaded and unloaded by 16 men. These are all the details available.

The baulks are plain, rectangular in section, cut for strength (in contradistinction to stiffness); 5 to the bay. The chesses are like our own, but with holes bored through the ends (reason unknown). The ribands are of the same shape as the baulks. The rack lashings are 4 on each side to the bay, sticks separate. There are no saddles.

Width of Bays:—*Normal,* or "4-gunwhale bridge," 4½-m. centres; can be increased to 4·8-m. centres for lighter bridge, or reduced to 3·30-m. centres for stiffer bridge. "Three-gunwhale bridge," 6-m. centres with baulks, 5-m. centres with chock baulks.

The trestles of the handbook are almost exactly like our Service Trestle, with transom suspended by a chain but without the clamping screws. Chock baulks are used with these, the bay being 5 mètres.

I have given these few details as they appear to be of general interest in emphasizing the difference of the *matériel.* A complete

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translation of the handbook would not enlighten us very much, as very few details are given and almost no dimensions. In fact, everything is simplified as much as possible; the *matériel* is issued to the Pioneer, he works with it and takes it as he finds it.

There are doubtless many other patterns of *matériel*, *e.g.*, the Bavarians have a sort of "Birago" equipment. There are some experimental trestles in Prussia with cross legs and transoms of steel piping and built-up W.I. baulks.

Demolitions and Mining are included in the Pioneer Company (Field and Siege) instruction text book, *Sprengvorschrift* (abbreviated *Spr V.*). This is very complete; and is full of illustrations where to place charges of the various kinds of explosives enumerated, and how to calculate their strength. Demolitions and Mining.

The rectangular case and mining frame like our own appear to be still in use; but trials have been made with a sort of triangular one, with flat sill and sides slightly convex outwards, made of T iron. The push pick is more spade shaped than ours. The miner's pick is more like an adze and there is in addition a broad hoe (not unlike the Indian *phaora*), 15 c.m. × 15 c.m., with 40-c.m. handle.

An illustration may be given of the manner in which siege works are practised. In 1894 a number of Pioneer Siege Companies and Artillery Fortress Companies were collected near Malmédy, where they constructed works and batteries as auxiliary fortress defences. Siege Works.

These defences were attacked in due form, live shell being fired at them. In 1896 similar siege operations were conducted near Jüterbog with the assistance of the Railway Brigade, who built a narrow gauge line, 51 miles long, in 9 days and transported 300,000 tons of siege material.

The Field Companies and Bridge Trains attend the Divisional, Corps, and Kaiser Manœuvres. Manœuvres.

In recent years the Germans have made more use of trench work than formerly. A good deal more would be undertaken were it not for the fear of fatiguing the men and causing excessive damage to crops, trees, etc. The Army Orders on the subject of manœuvres are very comprehensive and enjoin the employment of Pioneers. If the technical work cannot actually be carried out, the Pioneers, who would have to do the work, are to be taken to the spot and kept there for as long as the work would take in reality. Pioneer Officers are required to make all the necessary arrangements, take note of the military situation, and estimate materials, time, etc., reporting to the Officer in Command. Umpires in their decisions will take these works into account.

Great stress is laid on the value to Pioneers of noting the intimate connection that should exist between their work and the action of the troops taking part in the sham fight; and the very short time available for making field works should accentuate in the mind of the

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Pioneer Officer the practical utility of highly-trained technical troops. General Officers also, becoming accustomed to the presence of Pioneers, would learn to consider them in their march and disposition orders.

As a matter of fact very little trench work can be done, and most of the work of Pioneers on manœuvres consists in bridging. In fact the general spirit of the text books seems insensibly to lay more stress on bridging than on anything else, and the compiler of this article pleads guilty to have (almost unconsciously) been subjected to this influence himself.

After the manœuvres there is a period of comparative rest until 1st November, when winter work, divided into theoretical and practical, commences.

Winter Work.

Three classes are formed for theoretical instruction :—

(1). *Company :* for all men not recruits and not in classes (2) and (3). Lectures are given by the Sergeant-Major on the general duties of Pioneers, interior economy, etc. 16 hours a week are available.

(2). *Battalion :* for all N.C.O.'s, Gefreiter (lance ranks), re-engaged men, and selected one-year volunteers. Lectures are given by Officers on fortification, attack and defence, drawing, interior economy, military correspondence. 17 hours a week.

(3). *Foremen of Works Class :* for senior N.C.Os. wishing to become Wallmeister, *i.e.*, Assistants to the "Engineer" as distinguished from "Pioneer" Officers.

Practical work comprises :—drill, gymnastics, musketry at least once a week ; knotting and rowing drill preparatory to bridging ; solution of geometrical problems on the ground ; use of mechanical powers ; replacing and repairing broken wheels, poles, etc. ; moving heavy weights, trees, etc. ; topography, including sketches of fortifications ; demolitions of all kinds, including blowing up ice ; encampments and their subsidiary works, water supply, etc.

On 14th February, as before mentioned, the second-year men and recruits are mixed up together, and work proceeds as in the first year ; any portions of the course omitted in the first year are taken first after the preliminary work in the second year.

Summary of Training.

Roughly the training may be summarized thus :—

Infantry drill	10½ months.
Summer F.W. course	7 „
Winter	3½ „
Manœuvres	2 „
Leave and intervals	1 „
Total ...	24 months.

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As will be seen from the foregoing, the Pioneers have no leisure during peace for employment on Public Works. The whole of their service with the colours is devoted to their training for war. Employment in Peace.

TRAINING OF OTHER ARMS.

Infantry.—On the 1st June, each Infantry regiment sends a Lieutenant (Rifle battalions biennially) and each battalion two Corporals to the Pioneer battalion of their Army Corps for a course of 4 weeks. The 2nd in Command and a senior Lieutenant conduct the instruction, a certain number of Pioneer corporals and privates being detailed to assist.

There is no "shelter trench exercise." The diggers are extended in position at arm's length; each man then puts his spade into the ground at his feet and marks a line to his right-hand neighbour; this is the front cutting line; the back line is then marked according to directions.

Cavalry.—Every year, in June or July, an Officer or N.C.O. of Pioneers, accompanied by 2 or 3 men, is detached to each regiment of Cavalry for 15 days as instructor.

TEXT BOOKS.

Official Text Books appear to be unobtainable; those I have enumerated are published by private industry with official recognition. For convenience sake the whole art of the Pioneer has been boiled down into a small handbook, $6\frac{1}{4}'' \times 4\frac{3}{8}'' \times \frac{3}{4}''$, called *Pionier-Taschenbuch.* This is divided into 12 sections, as follows:—

1. Extracts from the Field Service Regulations.
2. Mensuration, with tables of cubes, squares, and functions of angles.
3. Mechanical powers and machines.
4. Carpentering.
5. Field Fortification, including siege work, revetments and use of brushwood.
6. Communications in the field.
7. Temporary bridge work.
8. Service of the field miner.
9. Encampments.
10. Field expedients.
11. Pontooning, and folding boats of cavalry.
12. Framing of reports, orders, etc.

The Pioneers have been subjected to a great deal of adverse criticism by writers in various German publications. Reorganization is in the air, but nothing official has transpired up to date (1.4.1905).

(To be continued).

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TABLE I.—DISTRIBUTION OF PIONEER BATTALIONS.

Army Corps.	Headquarters.	Pioneer Battn.	Station.
Guard	Berlin	Guard.	Berlin.
I.	Königsberg	1	Königsberg.
	(East Prussia)	18	
II.	Stettin (Pomerania)	17	Stettin.
III.	Berlin (Brandenburg)	3	Spandau.
IV.	Magdeburg (Prussian Saxony)	4	Magdeburg.
V.	Posen (Lower Silesia)	5	Glogan.
VI.	Breslau (Silesia)	6	Neisse.
VII.	Münster (Westphalia)	7	Deutz.
VIII.	Coblenz (Rhineland)	8	Coblenz.
IX.	Altona (Schleswig Holstein and Mecklenburg)	9	Harburg.
X.	Hanover	10	Minden.
XI.	Cassel (Thuringia & Nassau)	21	Münden.
XII. 1st Royal Saxon	Dresden	12	Dresden.
XIII. Royal Würtemburg	Stuttgart	13	Ulm.
XIV.	Karlsruhe (Baden)	14	Kehl.
XV.	Strassburg	15, 19	Strassburg.
XVI.	Metz	16, 20	Metz.
XVII.	Dantzig (West Prussia)	2	Thorn.
XVIII.	Frankfort-on-Main (Hesse)	11	Mainz (Mayence).
XIX. 2nd Royal Saxon	Leipzig	22	Riese.
I. Bavarian	Münich	3 Bav.	Münich.
II. ,,	Würzburg	2 Bav.	Speier.
III. ,,	Nuremberg	1 Bav.	Ingoldstadt.

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TABLE II.—ESTABLISHMENTS OF UNITS.

Units.	Strength (round numbers).			Baggage.			Depth in line of march including regulation distance.	
				Small.		Large		
	Individuals.	Horses.	Carriages.	Led horses.	Carriages.	Carriages.	Troops and small baggage.	Large baggage.
							Mètres.	Mètres.
A Pioneer Battalion of 3 Companies	810	60	14	6	6	8	400	90
A Divisional Bridge Train...	60	90	14	—	—	1	300	10
A Corps Bridge Train	200	220	34	—	—	—	800	—
A Pioneer Siege Train	310	160	59	—	—	—	—	—
A Pioneer Detachment, Cavalry Division	40	6	1	1	1	—	50	—
The Heavy Rhine Bridge Train	530	554	120	—	—	—	2200	—

NOTE.—The Battalion Officers are:—C.O., 2nd in Command, and Adjutant.

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TABLE III.—DETAILED ESTABLISHMENTS.

Details of Ranks, etc.	Pioneer Company.[1]				Special Pioneer detachment attached to Corps Bridge Train.		Pioneer detachment with Cavalry Division.			Remarks.
	Individuals.		Horses.	Carriages.	Individuals.	Horses.	Individuals.	Horses.	Carriages.	
	Higher Establishment.	Lower Establishment.								
Commander	1	1	2	—	—	—	—	—	—	
Lieutenant (mounted)	2	2	2	—	2	2	1	2	—	
„ (dismounted)	2	2	—	—	—	—	—	—	—	
Medical Officer	1	1	1	—	—	—	—	—	—	
Assist. Paymaster	1	1	—	—	—	—	—	—	—	
Sergt.-Major, vice S.M., and Ensign	3	3	—	—	1*a*	—	—	—	—	
Sergeants and other effective N.C.O.'s	21	17	—	—	6	—	3	—	—	
Lance ranks, Pioneers and Buglers...	225*b*	179*b*	—	—	54*c*	—	27	—	—	
Assist. Armourer	1	1	—	—	—	—	—	—	—	
Hospital Attendant		1	—	—	1	—	—	—	—	
Train Soldiers	10[2]	10[2]	—	—	2[2]	—	3[2]	—	—	
Tool Wagon	—	—	4	1	—	—	—	—	—	
Mining Wagon (explosives)	—	—	4	1	—	—	—	—	—	
Small Tool and Store Wagon	—	—	—	—	—	—	—	4	1	
Baggage Wagon	—	—	2	1	—	—	—	—	—	
Supply „	—	—	2	1	—	—	—	—	—	
Bicycles	—	—	—	2	—	—	—	—	—	
Totals	268	218	17	6	66	2	34	6	1	

[1] The company detaches to the attendant Divisional or Reserve Divisional Bridge Train 1 Depôt N.C.O., 1 Lance-Corporal, and 16 Pioneers (including 2 wheelwrights, 2 shoeing-smiths, 2 saddlers, 1 tailor, 1 shoemaker).

a. Sergeant-Major.

b. 3 buglers.

c. 1 bugler.

[2] Drivers and draft and baggage horses are furnished by the Train.

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Earthw

Carper
Brid

Demolitions .....

Explosives and their Appliances.

—	—	2	—	—	2	—	—	2	—	—	
—	—	4	1	—	4	1	25	4	1	—	
—	—	8	1	—	8	1	—	8	1	—	
—	—	6	6	—	6	6	29	6	6	29	
—	—	—	5	—	—	5	25	—	5	25	
—	—	3	—	—	3	—	5	3	—	5	
—	—	10	—	—	10	—	—	10	—	—	
—	—	—	—	—	—	—	—	—	—	—	
—	—	4	—	—	4	—	5	4	—	5	
—	—	—	—	—	—	—	—	—	—	—	
—	—	6	3	—	6	3	—	6	3	—	
—	—	2	—	—	2	—	—	2	—	—	
—	—	—	—	—	—	—	—	—	—	—	
—	—	—	—	—	—	—	—	—	—	—	
—	—	4	—	—	4	—	5	4	—	5	
—	—	3	—	—	3	—	5	3	—	5	
—	—	3	1	—	3	1	5	3	1	5	
—	—	—	3	—	—	3	—	—	3	—	
75	—	—	—	75	—	—	75	—	—	75	
—	—	—	4	—	—	4	—	—	4	—	
—	—	—	3	—	—	3	—	—	3	—	
—	—	—	10	—	—	10	—	—	10	—	
—	—	—	4	—	—	4	—	—	4	—	
—	—	—	2	—	—	2	—	—	2	—	
—	—	—	3	—	—	3	—	—	3	—	
—	—	—	286	—	—	286	—	—	286	—	
—	—	—	1	—	—	1	—	—	1	—	
—	—	—	1	—	—	1	—	—	1	—	
—	—	—	100	—	—	100	—	—	100	—	
—	—	—	12	—	—	12	—	—	12	—	
—	—	—	10	—	—	10	—	—	10	—	
—	—	—	600	—	—	600	—	—	600	—	
—	—	—	200	—	—	200	—	—	200	—	
—	—	—	50	—	—	50	—	—	50	—	
—	—	—	50	—	—	50	—	—	50	—	
—	—	—	600	—	—	600	—	—	600	—	
5000	—	20	8000	—	20	5000	—	20	—	12000	
—	—	100	—	—	100	—	—	100	—	—	
—	—	200	—	—	200	—	—	200	—	—	
—	—	200	—	—	200	—	—	200	—	—	
—	—	1800	—	—	1800	—	—	1800	—	—	
—	—	—	—	—	—	—	—	—	—	—	
—	—	15	—	—	15	—	—	15	—	—	
—	—	100	—	—	100	—	—	100	—	—	

Tools and materials for carpenters, joiners, wheelwrights, saddle and harness makers, smiths, tinsmit

[1] Company 200 strong.
[2] The shovels have straight end.

2 clamping , 1 scissors,

[6] Holding 1 cutting pliers, 1 flat pliers, 1 clamping pliers, 1 scissors, 1 knife, 2 rolls iron binding wire, 1 file, 1 copper hammer, 1 awl.

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TRANSCRIPT.

EXPLORATION AND SURVEY WITH THE TIBET FRONTIER COMMISSION, AND FROM GYANGTSE TO SIMLA *VIÂ* GARTOK.*

By MAJOR C. H. D. RYDER, D.S.O., R.E.

I. THE MAIN EXPEDITION.

IT has been said that the geographical results of the expedition to Lhasa have been disappointing. No one was better pleased than myself that this was in a sense true. Our knowledge of the country lying between our frontier and Lhasa depended chiefly on the surveys executed by different explorers trained by and working under the supervision of officers of my department—the Survey of India. They worked under extraordinary difficulties, and in great danger of their lives. That, when at last we have been able to carry through a regular and systematic survey of the country, we have not been able to find that the rough maps prepared from these explorers' surveys were in any important points other than very fairly accurate, reflects the very highest credit on these men, notably the late Pandit Nain Singh and the explorer A.-K., the latter of whom is still alive. In place of these rough maps, we have now an accurate survey of the country traversed by the expedition.

On September 24th, 1903, I received orders at Bangalore to join the Tibet Frontier Commission at Kampa Dzong. Proceeding *viâ* Calcutta, where I had to spend a few days collecting instruments and kit, I arrived at Silliguri, the railway base, on October 3rd, and marched out the same afternoon to Sevoke, where the Teesta leaves the hills. This was not the time of year to see the Teesta valley at its best; very hot, raining nearly every day, the march up the valley was far from pleasant, The cart road, now open as far as Gangtok, was then constantly blocked by landslips, and very slippery. After Gangtok was passed the views of the snows should have been magnificent, but the higher hills were veiled in clouds. All the more pleasant, therefore, was the marked change once the frontier pass, the Kangra La, was crossed; clouds were left behind, and during the two months I stayed at Kampa Dzong we

Kampa Dzong.

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had nothing but the finest weather, with that wonderful clear atmosphere which every traveller in Tibet has remarked on.

Down the long slope from the Kangra La, and over the rolling downs near the valley of Giri, the great snowy range gradually opened out, till on reaching Kampa Dzong, or at any rate from the hill above it, one continuous line of snows was visible stretching from Chumolarhi to Mount Everest, a distance of some 150 miles. We were able to survey from this snowy range northwards to the Arun river—Tsangpo watershed—the Tibetans, beyond sending men to watch us, making no attempt to stop us surveying so long as we did not camp away from the mission post.

As regards the heights of peaks, our results were of a negative nature. The highest point on the above-named watershed was 20,100 feet; the two "very high snowy mountains" mentioned by Mr. Freshfield on p. 362 of the *Geographical Journal* for March, 1904, quoting from one of the explorers, were disappointing, being only 21,200 feet in height. The fine snowy range apparently running north from Everest, in reality running north but some 30 miles east of Everest, has its highest summit at an elevation of 22,200 feet. The northern side of Everest has a continuous slope, which I estimated at 7,000 feet; and it is extremely unlikely that north of Everest, and hidden by the nearer snowy range, the peaks could again rise to a height anywhere approaching that of Everest. It is interesting here to note that Everest, as viewed from Kampa Dzong, does not appear as the highest peak of a group, but as one massive summit standing by itself. Nowhere could we hear of any local name for Everest, although careful inquiries were made. The height of Kampa Dzong itself proved to be 15,200 feet, instead of 13,800 as on previous maps.

Chumbi Valley.

Fortunately, just as we had completed all the surveying possible from Kampa Dzong under existing circumstances, it was decided that the Mission should retire from Kampa Dzong and advance over the Dzelap La and up the Chumbi valley. We accordingly hurried across Sikhim, and caught up the main body of the Mission and its escort at Chumbi. This valley is disappointing; it has always had a great reputation, but we found it to be only 200 or 300 yards wide, and not very rich. The houses at Rin-chen-gong are good, but that is not due to any richness in the valley itself, but to the fact that the Tomos, the inhabitants of the valley, have a monopoly of the carrying trade from Phari Dzong down into Sikhim.

A short halt here enabled me to get the lower end of the valley surveyed; and to detach Sub-Surveyor Dalbir Rai, who followed the valley down to the plains, and, returning to Gnatong by the adjoining valley, completed a most useful piece of work, including a hitherto unsurveyed portion of Bhutan.

The Mission then moved up to Phari Dzong and over the Tang La (15,200 feet), a very easy pass, to Tuna (14,800 feet). Here we spent the winter, and, except for some work in the Chumbi valley, surveying was nearly at a standstill; the Bhutan snowy range on the east, lower rounded hills on the west, and the Tibetan force at Guru, 6 miles north of

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us, limited our sphere of observation. The cold was intense, and a very unpleasant three months were spent before we again advanced. Towards the end of March Mr. Hayden, of the Geological Survey, and I, with an escort of twenty rifles, made a short excursion across the plain to explore the Lingshi La, a pass crossing the snowy range into Bhutan. Before, however, reaching this point, we were met by a small Tibetan force and requested to return. In view of my knowledge that Colonel F. Younghusband (the Commissioner) was very anxious to avoid, if possible, a collision with the Tibetans, I decided to retire to Tuna.

Brigadier-General J. R. L. Macdonald, R.E., and the main force having arrived at Tuna, it was decided to make a preliminary advance to Guru, where the Tibetans were encamped, and establish a post there. Unfortunately for them, the Tibetans decided to oppose our advance. A short fight took place, in which the Tibetans suffered heavily. On 2nd April Capt. H. McC. Cowie, R.E., joined us, just in time for the advance to Gyangtse, which took place on April 4th.

We camped on April 4th at Guru; we then marched round the shore of the Bam Tso to Chalu, and the following day did a short march down the narrow valley along which the stream flows connecting the Bam Tso with the Kala Tso. I ascended a point on the range between the two lakes, and had a fine view down on to both of them. The Bam Tso has an area of about 25 square miles, and the Kala Tso of about 15 square miles. Next day, April 7th, we had a level march to Mangtsa, where the open country ends. There is no outlet to the Kala Tso, but there are obvious signs that in ancient times the water flowed out of the lake into the narrow gorge, and so to Gyangtse and the Tsangpo. About 8 miles from the lake in this direction a small stream rises from what is probably an underground flow from the lake, and flows in a broad and deep bed down the gorge.

From Mangtsa the force marched to 3 miles short of Kangma, down a narrow gorge, while Capt. Cowie and I ascended the range to the east to a height of about 18,000 feet, to try and get a view ahead. In this we were not successful, still higher hills on the north on both sides of the gorge blocking our view. The Tibetans were reported by the mounted infantry to be in force holding a wall across the valley at Kangma; but next day their position, a strongly built wall, which, however, could have been easily turned, was found evacuated. Next day they were located in a position holding a narrow gorge, known as the Red Idol gorge, and the precipitous hills on either side. Out of this they were easily turned by a direct attack and a long flanking climb on the part of the Gurkhas. We camped at Sapu that evening, and marched on to the Gyangtse plain the following day. On April 11th the dzong, or fort, of Gyangtse was surrendered by the Tibetans, who seemed cowed by the defeats they had received. The Mission was established in a village on the right bank of the Nyang Chu, where there is a bridge, and about 1,000 yards from the dzong.

A force under Colonel Brander was left as escort, while the General and the main force returned to the Chumbi valley, leaving posts at Kangma, Kala Tso, and other places on the line. Gyangtse.

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We now settled down to a peaceful existence. A bazaar was established outside the post, and officers in small parties could wander about the plain shooting.

Capt. Cowie and I were then able to start triangulation off a measured base, and, with the help of three stations on the hills, we completed all the work that was possible. We were not then able to connect this triangulation with my Kampa Dzong and G.T. peaks, but we fixed some peaks on the Karo La range, which afterwards proved invaluable in connecting the Lhasa triangulation with this work.

Towards the end of the month a report came in that a force of Tibetans had collected on the Karo La, 45 miles from Gyangtse on the road to Lhasa. A party, consisting of fifty men of the 32nd Pioneers and thirty mounted infantry, under Lieut. Hodgson, was sent out to verify this report. As this would afford an opportunity of getting in a good addition to our map, I decided to accompany the party with Capt. Cowie.

We reached Ralung, two long marches from Gyangtse, on April 29th, and the following day, accompanied by the mounted infantry, rode up to the pass, about 2 miles beyond which we saw the wall which the Tibetans had built. Lieut. Hodgson took a few men forward to draw their fire and make them disclose their strength. In this he was successful, and, withdrawing his men without loss, although some Tibetans concealed on the hills above were rolling rocks down on him, we rode back to Ralung. I had intended taking the mounted infantry to Kangma in one long day's march, as it was important to have this route reconnoitred, but, owing to the presence of the Tibetans in such force on the Karo La, this was not now considered advisable, and we returned to Gyangtse in two marches, arriving there on May 2nd.

Colonel Brander decided to take out a force to turn the Tibetans out of their position on the Karo La, as they were threatening our line of communications. On May 3rd he accordingly started, Capt. Cowie again accompanying, as I hoped he might be able to get the route from Ralung to Kangma done this time. They attacked the Tibetans on the 6th, and drove them out of their position, but, owing to our having in the meantime been attacked at Gyangtse, Capt. Cowie had to return with the force.

On the 4th everything at Gyangtse seemed peaceful. I had been out for a long day surveying on the hills to the south, and on my return heard of a report, originating from one of the patients in Capt. Walton's civil hospital, that we were to be attacked next day. A small mounted infantry patrol went some miles down the Dongtse road, but found nobody. The Tibetan force, however, was at Dongtse itself, and, leaving when the moon rose about 1 a.m., attacked us just after dawn. Their attack was a complete surprise, but once our men turned out, the Tibetans were easily driven off with heavy loss. If, however, the Tibetans had not given the alarm by shouting and firing their guns, but rushed in with their swords, we should have been in a rather awkward position. Another force of theirs had in the meantime occupied the dzong, from whence they opened a heavy fire, which, to everyone's surprise, more than reached our post. The fighting in and around Gyangtse has been

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already often described; it culminated in the capture of the dzong on July 6th.

Capt. Cowie and Surveyor Sher Jang, who had come up with the relief force, now rejoined me, and on July 14th we commenced our march to Lhasa. Owing to the cloudy weather rendering triangulation impossible, I thought it advisable, in case we could not afterwards connect Lhasa and Gyangtse by triangulation, to run a subtense bar traverse; this entailed Capt. Cowie and I being on the road all day, starting with the advance guard and getting in in the evening. The weather, too, was very bad, heavy rain falling almost every day, effectually dispelling the prevailing notion that this part of Tibet is a rainless country. To Lhasa.

The Karo La (16,200 feet) was crossed on July 18th, the bulk of the Tibetans holding the position bolting the night before from the wall in the valley, leaving their companions on the hills to their left to escape as best they could. They were easily driven out of their position by the 8th Gurkhas, who established a record in hill fighting at high altitudes, the Tibetan position reaching an elevation of 18,500 feet and their retreat leading across the face of a glacier.

The next day the force moved to Nangkartse Dzong, in sight of the Yamdrok Tso. The snow-peak marked in former maps in the centre of the promontory, round which the Yamdrok Tso makes an almost complete circle, is a myth. No hill there has permanent snow, though, as their height is about 17,000 feet, there doubtless is often snow lying there when there is none at Nangkartse Dzong or on the shore of the lake (14,350 feet). After a day's halt we marched to Yarsik, where the original outlet of the lake obviously existed. We then marched for two more days along the shores of the lake, which all along this part is never more than 2 or 3 miles wide, and very often less.

We crossed the Kampa La (15,400 feet) on the 24th, an easy ascent from the lakeside but a very long drop down to the Tsangpo. Owing to the low elevation (11,550 feet) and Sarat Chandra Das's description, I thought that the valley would have been well wooded; this, however, was not so; the hills were quite bare, and no trees grew wild, though round every village there were fine groves. We moved on 6 miles down the river to the place selected for the crossing, where the Tibetans had kindly left a large ferry boat on our side of the river.

The whole force had crossed on the 30th, a very laborious process. The valley here is broad and well cultivated, the river running in most places in several broad channels with sandy islands in between. It was about at its highest flood-level soon after we had all crossed, with a very fast current and deep, and 140 yards wide.

On July 31st we moved off, and after a few miles turned up the Kyi Chu, a well-cultivated valley with a broad shallow river resembling the Tsangpo valley on a slightly smaller scale.

On August 2nd we arrived at the Tolung Chu, a large affluent of the Kyi Chu, and over which there is quite a good bridge. From here we were rewarded by our first sight of the Potala, the residence of the Dalai Lama, situated on a small isolated hill overlooking Lhasa.

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Lhasa.

Next day camp was moved to within a mile of the Potala; this was, however, only a temporary camp, and, being swampy, another site was selected on drier ground north of the town, the Mission being located in a very good house in pretty wooded grounds outside the town. The weather was not favourable for surveying—rain fell constantly, and heavy clouds lay on the surrounding hills; so Capt. Cowie and I confined ourselves, after measuring a base and observing a latitude and azimuth, to the survey of the town and suburbs of Lhasa on the scale of 6 inches to the mile. This took some time, as we were at first not allowed to enter the town itself; but later on, having got in all the somewhat extensive groves, gardens, and summer residences outside the town, we were allowed to march through the streets with an escort. In order to avoid attracting attention, for this portion of the work we did not use a plane-table, but made a compass and pace traverse from one fixed point outside through to another fixed point on the other side. The inhabitants showed some curiosity, but no hostility, at our proceedings. The height of the plain above sea-level is 11,830 feet. Capt. Cowie left Lhasa on August 29th for Gyangtse, to try and secure the connection in the triangulation between that town and the points I had fixed from Kampa Dzong. The weather now began to improve; and I was able to go out with a small escort, firstly, up the valley a day's march, from whence I took mounted infantry up to the junction of the Penbo Chu with the main valley, just opposite the Garden Monastery and some 30 miles from Lhasa; and, secondly, up the Tolung Chu, a somewhat similar expedition.

Having done these two trips, there only remained to go up on to the Penbo La, the pass on the main road leading north from and about 10 miles from Lhasa. This was important for the triangulation, and I was lucky to do all that was necessary in a short spell of fine weather, which just coincided with the five days I spent in camp at the foot of the pass, climbing an 18,000-foot hill each day.

From this range we were able to sketch in carefully the adjoining valley to the north, a broad, well-cultivated, and thickly populated plain; and from three stations I was able to connect on with the peaks of the Karo La range, and also to fix many points north and eastwards, including some fine snow-peaks south of the Tengri Nor, mentioned by Mr. Littledale, the highest of which was 23,250 feet in height and the highest peak we ever came across north of the Tsangpo. Two other snow-peaks which I fixed are, I believe, those mentioned by M. Bonvalot, and christened by him Mount Huc and Mount Gabet; but their heights were disappointing, the highest being 21,500 feet.

Return from Lhasa.

The treaty had been formally signed at the Potala on September 7th, and on the 23rd we left on our return march. On this occasion we recrossed the Tsangpo 10 miles higher up, and crossed the range between it and the Yamdrok Tso by the Do La, 16,000 feet, a long steep climb from the river. From this pass, the weather being clear, I had a fine view, and was able to fix a station by observations to peaks on the Karo La range and to two Bhutan peaks, already fixed from India, being also able to see and observe to one of my stations on the hills north of Lhasa. I had gone on ahead of the main force, with an escort of one hundred Gurkhas

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under Major Row. Next day we marched along the lake to Yasik, and I went up on to the range again, and, observing from two more stations, completed a good area of triangulation, and secured the required connection between the triangulation done from Gyangtse and that done at Lhasa.

At Yasik on September 30th we met Capt. Cowie, who, though much hampered by the cloudy weather, had effected a satisfactory connection between the Gyangtse triangulation and the Kampa Dzong work. We here struck off the main route up the side valley, across a very low, in fact almost inappreciable, watershed, and followed down the narrow valley, known lower down as the Rong Chu, which flows into the Tsangpo. I have no doubt whatever that this is the old outlet of the Yamdrok Tso, which now is landlocked. Next day we left the valley, camping near the Nyadong La (16,000 feet), crossed the pass next day, and so on to the plain above Ralung. This survey was useful, in that it showed the possibility of turning the Karo La. Capt. Cowie then made a round from Ralung into the Niru valley, down to Gobshi, and so to Gyangtse, while I caught the General up on the main road and accompanied the main force. I now made arrangements for Capt. Cowie to complete the work remaining between here and Chumbi, on which he writes as follows:—

"On October 8th, with Sub-Surveyor Hazrat Ali and a portion of the survey detachment, I left Gyangtse for Kangma, which was reached next day. Commencing a route-survey from this village on the 10th, we struck off the line of communications, marching eastwards through a narrow defile in the bare rocky hills dividing the waters of the Nyang Chu and the Niru Chu. As far as the Nilung La, which we crossed the same day, we followed the track which is part of the main road from Kangma to Ralung *viâ* the Wogya La. After crossing this pass and descending into the open plain, which receives the headwaters of the Niru Chu, we turned southwards, heading for the Rham Tso. Passing over the low rolling hills which intervened, we reached the lake on October 14th, completing the survey of this locality, and fixing the position of the Yu Tso, a lake lying at the foot of the snowfields of the big range culminating further to the south-west in Chumolhari. On the 14th I got into communication with the headquarters staff, who had just reached Kala Tso, and, for the purpose of adding to the half-inch survey of the Khambu valley, obtained sanction to strike off the line of communication at Tuna, and, crossing a pass some 12 miles west of the Tang La, to follow the course of Khambu Chu, eventually rejoining the line at Chumbi.

"Surveyor Sher Jang, who had accompanied the force from Gyangtse as far as Kala Tso, joined me at Chalu on the 14th. On the 16th we left Tuna, taking with us from there a Tibetan who professed to know the hills to the east of Powhanri, and camped in the small valley below the pass.

"On the evening of the 16th snow began to fall, and by the 17th and 18th a severe blizzard had set in. We left camp on the 17th in the midst of it, purposing to cross over into the Khambu valley, but were unable to

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reach even the pass. In consequence of mist and the thick driving snow it was impossible to see more than a few yards in any direction; we had no track to guide us, and the snow was nowhere less than 2 feet deep. The difficulties of progressing were great, and in addition we, the guide included, lost our way. Though only a few of the party were frost-bitten, many had begun to suffer from snow-blindness. Finding it impossible to proceed, with much trouble we eventually got back on the 18th to a point near our camping-ground of the 16th. Next day, with over 50 per cent. of the party incapable from snow-blindness, we crossed the Tang La and reached Phari in the evening. On the 22nd I reached Chumbi, and reported to the G.O.C. (the telegraph line having been broken by the storm), who had sent out a search party for us from Chumbi.

"All of the party had recovered from snow-blindness and the effects of exposure sufficiently to move to Chumbi on the 26th. The whole of the survey detachment left Chumbi on the 28th, and, marching *viâ* the Nathu La and Gangtok, reached Siliguri on November 5th."

Survey Results.

The survey results of the expedition are as follows:—

Triangulation.—An area of 45,000 square miles was completed, connecting Lhasa with India, and fixing all prominent peaks which were visible, with their heights.

Topography.—An area of 17,000 miles was surveyed on the scale of 4 miles to the inch, of which 3,000 square miles, in the neighbourhood of the Chumbi valley, Gyangtse, and Lhasa, were also surveyed on the scale of 2 miles to the inch.

Route surveys, on the scale of 1 inch to the mile, were made of the road to Lhasa.

Large-scale plans were also made of the towns of Gyangtse and Lhasa.

II. From Gyangtse to Gartok.

When the treaty was signed at Lhasa on September 7th, 1904, it was decided that a party should proceed to Gartok to examine the place, as is was one of the trade marts which the Lhasa Government had decided should be opened in Tibet. It was obvious that this would afford a great opportunity of adding to our geographical knowledge of the country. The ostensible object of the journey being a political outcome of the treaty, Capt. Rawling, of the Somersetshire Light Infantry, who in 1903 had made a remarkable and useful journey in Western Tibet, and who was now deputed to open the trade mart at Gartok, was placed in general control of the expedition. He was assisted by Lieut. Bailey, 32nd Pioneers, one of the few officers who have acquired a knowledge of the Tibetan language, which proved very useful to us; the survey party consisting, besides myself, of Capt. H. Wood, R.E., and Sub-Surveyor Ram Singh, R.S.

In making our arrangements for the journey, two considerations were paramount—firstly, that we should be having a race against winter, with a possibility that, should we be unable to get over the passes into India

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before the winter snow fell, the unpleasant prospect would have to be faced of having to winter at Gartok or some equally cold and inhospitable spot; secondly, it was quite impossible to tell whether and to what extent the Tibetans would assist us. Fighting had only lately ceased, the treaty had been signed barely a month previously, and there had been no opportunity of seeing whether the Tibetans would adhere to the treaty when our troops were withdrawn to India.

Our time for preparation was very short, every day's delay increasing the probability of our being snowed up. Capt. Wood and Lieut. Bailey arrived at Gyangtse, which was to be our starting-point, on September 30th, while Capt. Rawling and I only reached the same place on October 6th and 5th respectively.

Our transport we organized as follows:—Twenty-six baggage ponies to give us a nucleus of our own, should the Tibetans make difficulties about providing us with animals; seventeen riding ponies, it being important that, in view of long and continuous marching at a high elevation, as many men as possible should be mounted; one hundred yaks, lent to us from one of the transport yak corps to take us to Shigatse, but not to go beyond that town. From there onwards, however, the Tibetans invariably, and without any demur, provided us with whatever transport we required. Ponies, donkeys, mules, yaks, and coolies at various times carried our baggage, and, although it was difficult to supervise so large and mixed a caravan, no single article was lost during the whole time the journey lasted.

We took two months' supplies for all our men, with two months' extra of such things as ghi, goor, etc., which could not be obtained *en route;* while for the officers' mess we took four months' stores. Meat we could rely on obtaining in abundance, and tsamba or parched barley flour as long as we came across villages.

Our party was finally organized and ready to start on October 9th as follows:—

Capt. C. G. Rawling, Somersetshire Light Infantry; Capt. C. H. D. Ryder, R.E., Survey of India; Capt. H. Wood, R.E., Survey of India; Lieut. F. M. Bailey, 32nd Pioneers; Sub-Surveyor Ram Singh, R.S.; hospital assistant Hira Singh; three military surveyors; five sepoys of the 8th Gurkha Rifles; five survey khalassies; seven pony-drivers; two Hindustani servants; two Tibetan servants; Mahomed Isa, a Ladakhi, who acted as caravan leader; and last, but not least, a very small Lhasa Blenheim spaniel, who followed our fortunes throughout.

In order to have the advantage of the company of Capt. O'Connor, who was remaining as trade agent at Gyangtse, and who, with two other officers, was making a trip to Shigatse, we postponed our departure till the 10th.

Shigatse.

Our first day's march took us to Dongtse, the late headquarters and supply depôt of the Tibetan army which had attacked the Mission and its escort for two long months at Gyangtse; but here, like everywhere else, we were cordially received—mainly, I fancy, owing to our being accompanied by a Lhasa official, who had been deputed to escort us to Gartok, and also to our being supplied with a very strongly worded

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permit, signed with the seals of the Lhasa Government and of the three great Lhasa monasteries, and directing all officials along the route to render every assistance.

Three more marches, following the valley of the Nyang Chu, which is one of the richest and most prosperous valleys of Tibet, landed us at Shigatse on October 14th. Here we spent several busy days with an army of tailors, making warm clothing for ourselves and our men, lining all coats with lambskins, making fur caps and gloves, etc., till finally, when fitted out, we presented an appearance akin to Arctic explorers. Our stay at Shigatse was not, however, all work. We paid a most interesting visit to the great Tashi Lhunpo monastery, where the monks received us most cordially, showing us all over the place, and finally giving us refreshments of tea, cakes, and dried fruits. This monastery is said to contain four thousand monks, and although not so large as, is richer than, the great Lhasa monasteries. The bulk of the buildings, the residences of the monks, were of the usual type—narrow paved roads with high houses on each side, dirty, and not picturesque. But we also enjoyed the sight of the tombs of the five previous Tashi lamas, each a separate building with its golden roof and highly ornamented interior, filled with a wealth of turquoises, gold bowls, and rare old jade and cloisonné, the effect being somewhat marred by a foreground of small vessels holding lighted tapers fed by very evil-smelling butter. Bogle's description of his visit is very picturesque and accurate; the number of tombs has now, however, increased from three as seen by him to five as seen by us.

We were fortunate, also, in being received by the Tashi Lama, who, after holding an almost co-equal position to the Dalai Lama, has now, by the disposition of the latter, become the most important ecclesiastic in Tibet. He was living in his summer residence, a house outside the town, to which, with Capt. O'Connor as political officer at our head, we proceeded. A little hitch occurred at the gateway, as an arch-scoundrel, Colonel Ma, who had been the Chinese official at Gyangtse when we were attacked, and had never given us warning nor even tried to protect the servants and property of his colleague, Capt. Parr, was also paying a visit. Capt. O'Connor refused to enter the house while this individual was in it, and the latter had to be smuggled out by some back door. We were then shown up some steps and along dark passages till we arrived at the reception-room, at the far end of which we could see the Tashi Lama seated cross-legged on cushions on a raised platform. He received us each with a bow and a smile, which we returned; and we were then shown to seats on one side of the room, while the other side was filled with Tibetan officials and monks in either the ordinary maroon-coloured clothes usually worn by monks or in the yellow silk of the higher temporal officers. Tea, undrinkable as usual, was handed round, but on this occasion it had a certain glamour attached, due to its being served in enormous teapots of gold and silver. Dishes laden with sweetmeats and dried fruits were also brought in, but soon hurriedly removed and handed over to our followers.

While Capt. O'Connor was exchanging civilities with the Tashi

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Lama, we had time to think of the sudden change from a few months before, when the Tibetans, amongst whom was a strong contingent from this very place, Shigatse, were attacking us at Gyangtse, to the present moment, when we, a few unarmed officers, were sitting in amity with our quondam enemies. The Tashi Lama himself is an interesting personality; sixth holder of the office, his face is one that would not pass unnoticed anywhere, still less in Tibet. He has clear-cut features, high cheek-bones, and a pale complexion; his quiet dignified manner made a lasting impression on us. His age is only about twenty-three, and he seemed generally beloved and revered. During the whole of our visit a slight and pleasant smile never left his face. After silk scarves had been presented to us and our Tibetan followers had been blessed, we left, with the feeling, due partly to the personality of the Lama himself, partly to the room with its dim light, that we had been assisting at some religious ceremony.

We had commenced our survey at Dongtse, one march from Gyangtse; and as we wished to keep up triangulation, Capt. Wood and I left Shigatse on October 17th to do two short marches, the rest of the party leaving a day later and doing the two marches in one. Owing to bad weather, which gave us some rain and covered the surrounding hills with snow, we were unable to reach our hill, so decided to halt a day at Kangjen Gompa, a most delightful camp in a grove of trees. This was the same storm which entailed such hardships on our force returning to India in the neighbourhood of Phari Dzong. Fortunately for us, we were here at the lowest point of our journey, the height of Shigatse being 12,570 feet, and escaped with only slight inconvenience.

By visiting these hills, one of which was over 18,500 feet in height, and from two of which we had fine views of Mount Everest, Capt. Wood was enabled to carry on the triangulation under very adverse circumstances. To climb one of these hills is itself a hard piece of work; to observe at the top in a bitter wind is one of the most physically painful operations I have ever experienced. To do this in combination with a day's march leads to a very long and hard day's work. Capt. Wood carried this on for days and months with hardly any intermission—a feat which could only have been accomplished by an officer of his energy and determination.

Up the Tsangpo.

Until we reached Pindzoling, on October 22nd, the river had been a few miles to the north of our route, but from thence we followed the river more closely. Two more marches and we were at Lhatse Dzong; a dzong or fort on a small rocky hill, very similar to those at Shigatse and Gyangtse, surrounded on one side by the river and on the others by a fair-sized monastery and a small town. The valley here widens out into a plain, cultivated in parts, barren elsewhere. At Lhatse Dzong we halted a day, which enabled Capt. Wood and I to ascend a hill a few miles east of the town, overlooking a broad bare valley which leads to the very famous Sakya monastery. We regretted that want of time, and the consideration that it was not advisable to divide into two parties until we had thoroughly tested the friendly disposition of the Tibetans, had prevented us from paying a visit to this monastery.

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From Lhatse, however, the Tibetans having shown no desire but to assist us in every way, we decided to separate. While Capt. Wood and Lieut. Bailey followed the main route, which here crosses and leaves the river, Capt. Rawling and I stuck to a route reported to follow up the south bank, as I did not wish, if possible, to omit any portion of the river from our survey.

Accordingly, on the 26th we parted company, camping that night on opposite sides of the valley, which now closed in. We kept to the river the following day, but on the 28th we had to leave it, and for two marches followed up a side stream, the Chi Chu, running parallel to and only 2 or 3 miles distant from the Tsangpo, which we again rejoined on the 30th. On November 1st we could see that the river ran between rocky hills with snow-peaks on either side, and had to leave it, making a wide *détour* to the south. We marched up a side nullah, camping in bitter cold at nearly 16,000 feet, and crossing the Kura La, a very desolate pass, next day, at an elevation of 17,900 feet. Marching across the head of a plain which forms the headwaters of the Chi Chu, previously mentioned, we passed over an almost imperceptible watershed down a narrow stony valley to the village of Kaju. We had had a magnificent view of the main Himalayan range from a hill a few hundred feet above the pass. Mount Everest stood up towering above the rest of the range in its neighbourhood in one isolated peak, a continuous drop of some 8,000 feet separating it from the rest of the range east and west of it. The village of Kaju (14,800 feet) lies on the edge of the Sutso Tang plain, which takes its name from an old ruined fort on a small eminence in its centre. It is here about 5 miles wide, and we could see it trending away southwards and joining the Dingri maidan, which lies north of Mount Everest. A day's halt here enabled me to cross this plain, from the hills on the western side of which I obtained an uninterrupted view of Mount Everest, no hills intervening. I was thus able to satisfactorily establish the fact, which I had suspected a year before at Kampa Dzong, that no peaks anywhere approaching the height of Everest exist to the north of it or anywhere in its neighbourhood; it stands alone in its magnificent solitude, and is entirely disconnected from the mass to the west, of which Peak XX. (Gaurisankar) is the best-known point; on the south-east of Everest, but separated from it by a low gap, lies Peak XIII. (Makalu). We were here in the valley of the western branch of the Arun or Kosi river, but, recrossing the watershed next day by the Sheru La (17,600 feet) we once more reached the banks of the Tsangpo on November 5th. The scenery was now changing; trees we had said good-bye to some marches back, our last cultivation we passed that day, while the hills were becoming more open and the plains abounded in sand-dunes. Brushwood was in places available for fuel, but we preferred argol, or dried yak-dung, as it gave greater heat, and, if the fire was carefully looked after, less smoke. During the whole of this portion of the river journey we had seen no four-footed game other than numerous hares, and a few gazelle on the Sutso Tang plain; but birds we saw and shot numbers of, Tibetan partridge (ramchikor) and Tibetan sand-grouse giving us a welcome change in our otherwise monotonous fare of mutton.

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On the 6th we crossed to the north bank of the river with the utmost difficulty. A crazy-looking punt, manned by lamas, took us across in detachments; but, owing to the masses of floating ice whirled down the river by the rapid current, the punt was repeatedly forced back, and only reached the opposite shore after floating down some 400 yards; and the operation of hauling the boat up each time against the ice to its original starting-point was very hard work. On the 9th we arrived at Saka Dzong, a small village, and found that Capt. Wood's party had reached there two days previously. We gave ourselves another day's halt here, as there was a good deal of surveying to be done in the neighbourhood.

Capt. Wood writes as follows, regarding his journey:—

"Leaving Lhatse on October 26th, we crossed the Tsangpo about half a mile below the town. A couple of boats had been collected by the Tibetans for ferrying across our kit and transport, but the process was very much shortened by the discovery of a ford about a quarter of a mile upstream, by which the ponies were able to cross. After keeping to the north bank for about 10 miles, we turned up a side nullah and camped at Sanggelung village; following this nullah next day for a short distance, we crossed by an easy pass into a country the drainage of which led into a succession of small lakes, whose surfaces were covered with geese and duck. On the largest of these, the Ngap-ring Tso, a tasam, or stage-house, is situated, which place we reached on the 27th. Hearing that no grain would be procurable until we reached Barkha, on the Mansarowar lake, we bought all we could procure, but even this would only give our ponies a couple of pounds daily. The next day we passed Ralung, the last place we saw cultivation. Every day now found us at a higher altitude, as we were marching more or less along the watershed between the Tsangpo and its large tributary, the Raga Tsangpo. The valley of this latter stream is narrow, running almost due east and west, parallel to and about 30 miles to the north of the main river. Into this distance is crammed a tangled mass of hills, whose crests average about 18,500 feet, with several peaks of about 22,000 feet covered with permanent snow. This part of our march was exceptionally unpleasant, as the wind on the hills never dropped by day below hurricane force, and, camping at elevations up to 16,100 feet, the change in temperature from the comparatively warm valley of the Tsangpo was most noticeable. The hills, clothed with a coarse grass on their lower slopes, but quite bare above 17,000 feet, were, as a rule, easy to climb; and from the summits lovely views of the Himalayas were obtained, Makalu and Everest, both standing out as great isolated peaks, being particularly imposing. The tasams, at which every four or five days we changed our yaks for fresh ones, were the only signs of habitations we met with, and these, as a rule, consisted of tents with a mud hut or two. The marches were all long and wearisome in their monotony, and, owing to the narrowness of the valley, Ram Singh and I, to carry on the survey, had to climb to the crests of the range every day, seldom getting into camp before sunset, and on one or two occasions not arriving before nine or ten at night. On November 5th we crossed the Ku La (16,700 feet), situated at the

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headwaters of the Raga Tsangpo, and by a steep descent dropped into the valley of a small stream draining into the Tsangpo. At that night's camp we received letters from Capt. Ryder, saying that he would arrive at Saka Dzong on the 9th. Passing under the snowy range of Chour Dzong, whose peaks range up to 21,000 feet, we reached Saka Dzong on November 7th."

Saka Dzong. During our halt at Saka Dzong, Capt. Wood ascended a high peak to the north (19,300 feet), from which he had a fine view north up the valley of the Chata Tsangpo, a tributary of the main river.

Saka Dzong has only a dozen or so houses, very dirty, the neighbourhood (height 15,150 feet) being, like that of every Tibetan village, a dust and refuse heap. We left on November 11th, again in two parties. This time Lieut. Bailey accompanied me back to the river, while Capts. Rawling and Wood followed the main route. That day we forded the Charta Tsangpo, a fair-sized affluent of the main river, and, crossing some low hills, reached the Tsangpo on the 12th, crossing the same evening late, it being necessary to do so then, as from my previous experience I knew that the river would be nearly impassable in the morning from floating ice. We crossed in a small skin-boat, our animals fording higher up. For several days we marched upstream in a broad valley covered with low sand-dunes and stones, with a very small quantity of poor-looking grass, on which, however, kyang and gazelle seemed to thrive. The track followed by the Pandit Nain Singh, as he marched up from Nepal to Tradom in 1865, joined in on our left, but in these plains in Tibet it is difficult to find any signs of a path, as every caravan meanders over the plain without keeping to any defined track.

Tradom. We recrossed the river on the 16th; but now it was completely frozen over, and we crossed on the ice, the only thing necessary being to make a good track for the animals by throwing some earth down on the ice. That evening we arrived at Tradom, where we found the rest of the party had arrived on the 14th. The weather had been taking a turn for the worse; low temperatures at night we always had, cold winds in the day were the rule; but if the days were sunny a little walking would soon make us warm; when the days were cloudy, however, there was nothing to counteract the cold, and a march was a most miserable performance.

Captain Wood writes: "On leaving Saka Dzong, our party kept down the valley till we reached the Chata Tsangpo, which we found no difficulty in crossing. The stream was at that time some 100 feet in width, with a depth of 2 feet, flowing in one channel, having just left a very deep narrow valley to emerge into a plain of about 3 miles in width. Striking up a small side nullah, we followed it for 5 miles, and camped at the foot of the Lalung La. On this pass we first saw signs of *Ovis Ammon*, and from the information we received this appears to be the Eastern limit of their country along the road we had traversed. The road for the next three days—if it can be called a road—was the worst we met with, and consisted of large broken rocks set in deep sand; and to make us even more uncomfortable, the weather changed to snow, accompanied, as usual, by a howling gale of wind. Inhospitable as Tradom appeared to us when we first descried it, we hurried on, as fast

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as our ponies would take us, to get within the shelter of its single stone house, where we might warm our frozen limbs over a yak-dung fire, and pity the remainder of our party who had still another two days to endure before they could hope to join us."

Tradom did not tempt us to halt; it is a desolate spot, with a small monastery on the hill above, inhabited by only three or four monks; but from the hills to the north we had a fine view of a snowy range reaching an elevation of 23,200 feet. We accordingly left the next day, and, marching across the plain all day, camped amongst the hills on the far side. This plain is full of small ponds lying among sand-dunes, and there was an unpleasant tributary or two to cross, the water frozen at the edges for 4 or 5 yards, then a drop of 3 feet into icy-cold water full of floating ice, and finally a scramble out on the other side on to ice again.

Source of the Tsangpo.

We now followed the river valley for a week or so, always in the same large plains, until we could see the watershed range ahead of us, from the valleys of which innumerable streams issue to form the Tsangpo, the largest coming from a snowy range to the south-west. After enjoying some days of bright sunshine, the weather again took a turn for the worse, and we crossed the Mayum La (16,900 feet) on November 26th with a foot or two of snow on the ground. We had now finished with the Tsangpo, having surveyed it from Shigatse to its source. Our next point of interest was to be the lake region ahead of us. The day after crossing the Mayum La we camped on the northern shore of the Gunchu Tso, a lake 11 miles long by 2 or 3 miles broad, with an area of 22 square miles, completely frozen over and having no outlet at all. Several *Ovis Hodgsonii* (*ammon*) had been shot before reaching the Mayum La; and we now came on large herds of Tibetan antelope, of which we each shot several, and could have shot many more if we had wished, as they were very tame.

Mansarowar Lake.

Crossing several low passes and generally undulating ground, we came in sight of the Mansarowar lake (Tibetan Tso Mobang) on November 30th. The lake is neither impressive nor beautiful, like, say, the Yamdrok Tso, passed on the way to Lhasa. It was not frozen over, except for 100 yards or so round the edge; the water was fresh, and our surveyor, Ram Singh, on account of its sanctity, bottled some and carried it back with him to his home in Dehra Dun. Skirting the lake, we rode across the low hills, which close in on the western side, to look for the outlet, which Moorcroft had not been able to find, which Strachey had found, and which Mr. Savage Landor had claimed to have proved did not exist. We struck the channel a mile below the outlet, a small stream only partly frozen over; this we followed up, and found that it did not flow from the lake, but from a hot spring, at which we found and shot some mallard. We then followed up the dry nullah to the lake, and proved that Strachey was, as was to be expected, quite correct. No water was flowing at this time of year, but the local Tibetans all agreed that for some months in each year there was a flow during the rainy season and the melting of the snows, *i.e.*, about from June to September. As a rise of about 2 feet in the level of the lake would cause water to flow down the channel, this

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appears quite worthy of belief. The channel runs westward to another lake, the Rakas Tal (Tibetan Lagang Tso), about 3 miles distant.

That day, December 2nd, we reached a Tibetan stage-house, and next day had a long day's ride to try and discover an outlet for the second lake. This is very dissimilar to the Mansarowar in shape, and was entirely frozen over. The latter is about the same width, 12 miles, north and south as it is east and west, with an area of 110 square miles; the former is a long narrow lake running north and south, some 16 miles long by 3 or 4 miles wide, with an area of about 55 square miles. It is the sacred character of the Mansarowar lake rather than its size which has made it well known; its height above sea-level is 14,900 feet.

Source of the Sutlej.

We found an old stream-bed issuing from the Rakas Tal, but every Tibetan we asked told the same story—that no water ever flowed along it now, but that in days gone by, one man saying before the Sikh war, water did flow out of the lake and down this channel. We followed it down for some 6 miles along the plain, and could find none of the ordinary signs that water flowed down it until we reached some low hills; here evidently, from the lie of the sand, water flowed at some time of the year, and away from the lake. The lakes being now entirely disconnected at all times of the year from the Sutlej river, the sources of that river must lie in the hills on either side of the valley and west of the lake region.

The Kailas peak was very prominent on the hills to the north, snow-covered, 21,800 feet in height. The strata forming the mountain are horizontal, which gives it a peculiar appearance; from the side we saw it, the top was quite inaccessible. There are several monasteries on the path which pilgrims follow in circumambulating the mountain. A very fine snow-mass, culminating in a peak over 25,000 in height, Mémo or Gurla Mandhata, lies to the south of the Mansarowar lake. A low water-shed south-west of the lake leads to Purang or Takla Kot.

Gartok.

Keeping to the north side of the broad open valley in which the Sutlej flows, we arrived at another stage, Menzé or Missar, on December 5th. Here we divided, sending our heavy baggage down the valley with Ram Singh, as I wanted him to continue the survey of the Sutlej valley while we went into Gartok. We were pleasantly surprised to find the Jerko La, the pass on the Sutlej-Indus watershed, low and easy (16,200 feet), and without difficulty reached Gartok (15,100 feet) on the 9th. This is the summer residence, Garyarsa; the two Garpons, the joint governors of Western Tibet, were residing at Gargunsa, the winter residence, some 30 miles down the valley, but had come up to receive us.

We only halted one day at Gartok; in that time we had seen more than enough of it. We were unanimous in looking on it as one of the most dreary inhabited places we had struck in our journey. A long broad plain, absolutely bare, with a dozen wretched hovels in the middle, constitutes at this time of year what is in summer the chief trading centre of Western Tibet; but in summer traders are said to collect in large numbers, living in tents. The wind howled continuously round the hut we were in, and, the weather looking threatening, we were not anxious to stay a minute longer than was necessary for Capt. Rawling to settle up trade questions with the Garpons.

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Down the Sutlej to Simla.

Having now accomplished the main object of our journey, it only remained for us to get back into India as soon as possible. Fortune had favoured us so far, but we had some high passes to cross. The first of these was the Ayi La, height 18,700 feet. Two marches took us to near the top of the pass, encountering a blizzard the second day. That evening we saw the only herd of wild yak we had come across in our journey. Crossing the pass next day was no easy matter; the ascent was gradual, but there were 2 feet of snow on the ground and a bitterly cold wind was blowing. It was with the utmost difficulty that, under some shelter from a rock, I took boiling-point observations, and with a sigh of relief hurried down the other side. One of our chief obstacles was surmounted. It began snowing on the pass that evening, so we had only just crossed in the nick of time. At Dunkar (14,100 feet), where we camped that night, we met cultivation for the first time, and it was a pleasant sensation to feel that we were gradually coming to the end of high altitudes.

From here Capt. Rawling and Lieut. Bailey next day marched to Totling (Tibetan Tuling), on the Sutlej, where they met Ram Singh's party. Capt. Wood and I halted a day at Dunkar, and marched next day to Tibu, where the whole party was once more united. We were now in the most cut-up country I have ever seen; it must resemble the loess formation of China. The bottom of every nullah was some hundreds of feet below the general level of the valley, with their edges so cut and worn into fantastic shapes that it was difficult to believe that one was not looking on the ruins of old castles. There are also innumerable caves, in which the inhabitants live.

On December 16th, at Kyinipuk, we met Thakur Jai Chand, who had been sent up to be our trade agent at Gartok. He brought with him some very welcome newspapers. I must own we none of us envied him his job for the winter.

Each day's march now consisted of climbing up out of a deep nullah and down again into the next. We crossed the Shiring La (16,400 feet) on the 21st, in deep snow, with great difficulty, the descent on the western side being very bad going. Next day we camped at Tyak, on the Sutlej, which had been flowing on the left of our route only a few miles distant, but invisible to us owing to its being at the bottom of a deep gorge. On the 23rd we marched to Shipki, crossing the river on the ice, elevation 9,300 feet. On Christmas Eve we surmounted our last obstacle, the Shipki La on the frontier—a climb of 5,000 feet, mostly in snow, and a drop of 6,000 feet on the other side—and camped at Khab in British territory. From here we had eighteen marches into Simla, finding bungalows at every stage on and after December 28th, finally arriving at Simla on January 11th.

Survey Results.

The area we surveyed with the plane-table comes to about 40,000 square miles. We surveyed the Tsangpo from Shigatse to its source; surveyed the Mansarowar lake region, and settled the doubtful points connected with it, which have been the subject of much discussion; we completed the survey of the Sutlej river from its source to where it enters British territory, and surveyed the source of the Gartok branch of the Indus.

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The triangulation, which is still under computation, was invaluable to correcting the plane-table work and fixing many heights.

The cold we had to contend against was at times very severe; the lowest minimum we recorded was $-24°$ Fahr., but as the thermometer always registers its lowest on clear still nights it is not a good guide. It may be generally said that when the air was still the cold was quite endurable, and on sunny days, out of the wind, no climate could have been more pleasant. When, however, the wind blew, which, I am sorry to say, was generally the case, no clothing ever invented was sufficient to keep one warm. When a hurricane occurred on a cloudy day, our surveying was done with lightning rapidity, our great object being to hurry on to the friendly shelter afforded us by our tents; but the constant change of scenery, and the interest of our journey, did much to counteract the discomforts we met with.

My companions will agree with me that the success attending our journey was in the first place due to the friendly attitude of the Tibetans, induced by the cordial relations which Sir Frank Younghusband had established with the Lhasa Government. We were indeed glad to be able, by only two or three months' hard work on our part, to prove that the treaty signed at Lhasa was not merely a paper one, as might so easily have been the case, but that it inaugurated an era of truly friendly relations between ourselves and the Tibetans.

I am greatly indebted to my companions, Capt. Rawling and Lieut. Bailey, for the ready assistance and hard work they underwent in furthering the survey work, in which Capt. Wood and our native surveyor, Ram Singh, proved themselves sterling workers.

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REVIEW.

THE LIFE OF GENERAL SIR ANDREW CLARKE.

By Col. R. H. Vetch, c.b.—(John Murray. 15s.).

Colonel Vetch has had a difficult task to perform. To compress within the limits of one volume, and that of a manageable size, the mass of interesting and valuable material which has been placed at his disposal, could have been no easy matter and he may be fairly congratulated on the manner in which he has accomplished his labours. "The Life of Sir Andrew Clarke" is one which may be studied with advantage by every officer of the Corps; in each chapter there is much that is of interest and in most there is something to be found of real value to us whether as soldiers, engineers, or administrators; indeed, if there is a fault to be found with what is otherwise an excellent biography, it is that Colonel Vetch, while giving us an admirable narrative of Sir Andrew's official duties and achievements, has tied himself down too much to these and has but little revealed Sir Andrew's personal qualities, and has made but few references to that wonderful magnetism which he so successfully exercised and to that gift of getting others to work heartily and willingly for him which he, like so many other really great men, so largely possessed.

The value of this book is greatly enhanced by the admirable "foreword" which Sir George Sydenham Clarke has supplied. As he so truly points out Sir Andrew's training had been of the most varied, and—for a military officer—of the most exceptional nature. "It was a kind of training which our Empire alone can provide for its sons and to the value of which Lord Cromer has recently paid a striking tribute."

To Mrs. Sueter our thanks are due for the excellent portraits so faithfully reproduced and for the trouble she has taken to enable the compiler to have all the correspondence at his command.

To the younger officers of the Corps we commend this book as well worth their study. It shews how a young R.E. subaltern, starting with no particular advantages and no powerful friends, was able by dint of his own faculties and exertions to obtain the "blue ribbon" of his profession, to reach some of the highest positions in the service of his country, and to leave a mark for good on every Department over which he presided.

Sir Andrew's public life falls naturally into four distinct phases—his early career in Australasia—the Directorship of Works at the Admiralty—his Governorship of the Straits Settlement and on the Council in India—and his tenure of the offices of C.S.M.E. and I.G.F.

Born at Southsea in 1824—the son of Colonel Clarke, k.h., formerly of the 46th Foot—Andrew Clarke passed into the "Shop" at sixteen. From the very first he gives evidence of having a careful mind and of

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being "a first-class fighting man," for [unlike most cadets of that period we should imagine] he kept a diary, and in it we find a record of a fight with his old friend the late General Sir Michael Biddulph.

"8 March.—Biddulph impudent to me at drill. Kicked him.

11 March.—Biddulph made corporal.

14 March.—Biddulph challenged me for what occurred on Tuesday. Refused to fight on this score, but allowed him any other. Struck me on the stairs. We met in the Fourth Racket Court. First two rounds I got the best, but my wind did not do so well the other two. Hammer and tongs work. Separated. Biddulph apologized. Shook hands. Done up.

15 March.—Went into hospital with my face very much swollen. By the bye Buck was my second."

Clarke passed out first in his batch, took Sappers in June, 1844, and went from Woolwich for the customary course at Chatham. That he was not impressed with the Chatham curriculum of those days is evident from a letter written to his uncle afterwards, when he had served elsewhere (1850).

"I wish in the first instance, instead of going to Chatham, I had been sent abroad. When will the good folk in Pall Mall see the great advantages that would accrue from sending the young officers of Engineers abroad at once, and let them on their return serve for a year under the School of Instruction at Chatham? Chatham has ruined and spoilt ten times more good officers than it has taught their service and duty. It will be left to me when I am Adjutant-General or Inspector-General to create this change!"

His father meanwhile having been appointed to the Governorship of Western Australia, Clarke applied to be sent to Van Diemen's Land or Australia. He obtained his wish, was given command of a detachment of Sappers proceeding to Van Diemen's Land, and luckily for himself was ordered to embark in the same ship which took out the new Governor.

Sir William Denison, himself an old R.E., the brother of the Speaker of the House of Commons and of the Bishop of Salisbury, was doubtless soon attracted by Clarke's bright and winning manner and from that time interested himself in the young subaltern and helped to further him in his future career. "It was the luckiest day of my life," he writes to his uncle, Mr. William Hislop Clarke, "in which I first met my present chief and friend Sir William Denison. Had it not been for him I should have been but a mere drudging sub. of Engineers, still dreaming on and still castle-building; now I find myself, it is true, but at the lowest rungs of the ladder, but the ladder is there."

The ladder was there indeed and Clarke was not the man to miss his footing. Within three years Sir William Denison's private secretary died, and the appointment was offered to Clarke, at that moment road making with his sappers in New Zealand during the first Maori War.

His letters to his uncle written at this time form some of the most interesting parts of the biography. In them he describes his duties, his expeditions with his chief (either inspecting or hunting), his command of the Body Guard, his membership of the Legislative Council. His uncle advises him to lay by for a rainy day; but Clarke regrets that while the

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means were somewhat increased, the expenditure was apparently unendable. "I hope however that by the time I return home I shall have a good balance with Cox. This is at present a mere pleasant dream. I I have often thought what a splendid effort it must have been on the part of my dearest father, subduing apparently that innate failing of all our characters—not knowing correctly the measure of our cloth for the coat we intended to wear."

Clarke was not long in gaining the respect of the Legislative Council and was beginning to be recognized as a power in the Colony; but he wanted a wider field for his energies, and this was not long in coming. The District of Port Phillip—recently separated from New South Wales and created a new Colony under the name of Victoria—wanted a Surveyor-General and Clarke was offered the post with a seat in the Council. Sir William Denison fully approved of his accepting, and in a letter which will be read with deep interest bade Andrew Clarke God-speed in his new career.

At the early age of 28 Clarke, still a subaltern in the Corps, now found himself at the head of a public Department; as a member of the Legislative Council of Victoria he was entrusted with all municipal legislation and as Surveyor-General had sole charge of all Public Lands. The five years (1853—1858) during which he held this appointment gave him an administrative training such as has fallen to the lot of few officers of the Corps.

Twelve years had passed (1858) since Clarke had left home; and the War Office now called on him either to elect to remain in civil employment or return to the Corps. He returned to England early in 1859 and for the next 5 years was employed on military duties; he was C.R.E. at Colchester and afterwards at Birmingham—he was disappointed in an offer of the A.D.C.-ship to Sir John Burgoyne—he acted as Agent-General for Victoria, and was sent as a special service officer to Cape Coast Castle where the Ashantis were giving trouble, and he published a report on the Gold Coast which was the best description available at the time of the subsequent Ashanti War.

To Australia Clarke owed many things and perhaps not second even to his early connection with Sir William Denison, was his lifelong friendship with Mr. Childers. The latter, three years the younger of the two, had arrived in Melbourne two years before Clarke; they had been called together to take part in the first Government of the colony and had together assisted to draft the bill for its new constitution. They early learned to respect each other and to appreciate each other's remarkable abilities. When their work was done in Australia they again met in the old country, where their early acquaintance was destined to be on two occasions of great advantage to the country. Mr. Childers, who had now been four years in Parliament, became Civil Lord of the Admiralty under the Duke of Somerset in the spring of 1864 and in the following August was able to suggest Clarke's name for the Office of Director of Works at the Admiralty in the place of Colonel Greene, C.B., an old R.E., who had just vacated it. No better appointment could have been made, and it was fortunate for the service that at so opportune a

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moment his abilities were recognised. Had it not been for their collaboration in the early Australian Government, it is unlikely that this would have happened.

For the next nine years (1864 to 1873) Clarke's work was intimately connected with the welfare of the Navy and it is doubtless due to this fact that appreciation of our Naval needs and sympathy with the sailor characterized in so marked a degree his despatches and minutes from this time onward. He came to Spring Gardens at a critical moment; the old wooden fleet was giving place to the ironclad squadron, new dock accommodation was urgently called for, large extensions of existing yards were essential, and the Government of the day was called to lay out many millions to carry through these works. In the Director of Works technical knowledge was undoubtedly needed but it was by no means the only qualification. To convince a reluctant Chancellor of the Exchequer (at that time at daggers drawn with his own Prime Minister on questions of economy) of the necessity of this or that Naval expenditure was no easy matter. Lord Palmerston and the Duke of Somerset generally took one line, Mr. Gladstone and Mr. Childers took another. Diplomacy, good temper, and patience were essential, and Clarke proved himself indispensable. To him we are indebted for the initiation of the great dockyard extensions at Portsmouth, Chatham and Malta, he was responsible for the success of the Bermuda floating dock, he urged on the completion of Portland breakwater, and by his personal efforts he overcame Lord Palmerston's objections to spending money on the extension of Dover Harbour.

It is in dealing with this portion of his career that Colonel Vetch has brought to light, we believe for the first time, the fact that Clarke was the first to point out the advantages of the purchase of the Suez Canal shares. The French shareholders were willing to be bought out and at Clarke's instance Mr. Childers brought the matter before the Cabinet and supported it strongly; but without success. "I am sorry," he wrote, "and have done my best. Granville was with me. Cardwell and Lowe the other way. Gladstone at first my way."

In May, 1872, Lord Kimberley offered Clarke the Government of the Straits Settlements and for the next eight years he was once more abroad. We have no hesitation in considering Clarke's work while at Singapore to be the most important service he rendered to his country, and Colonel Vetch has been well advised in treating these services in full detail. How he cemented friendship with Siam, composed the faction quarrels of the Chiefs of the scattered Malay States, how he put down piracy and persuaded the Chinese headmen to surrender their junks and to destroy their stockades, and finally how he did not hesitate to appoint Residents to the Native States on his own responsibility, these the reader will find carefully and accurately recorded in Chapters VI. to VIII. Sir Andrew was only 18 months at Singapore but they were months of "strenuous life." In Colonel Vetch's words "He is honoured with a place next to Sir Stamford Raffles in public estimation as the author of progress in the Malay peninsula. . . . In 1874 the revenue of the two native States, Perak and Selangor, was 100,000 dollars which went into the pockets of native

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Chiefs for their own selfish indulgence. In 1900 the revenue of these States had risen to 13,500,000 dollars and paid for an administration which promoted the peace and prosperity of the country."

We have always considered it was unfortunate for the public service that Sir Andrew was persuaded to exchange the Governorship of the Straits for a seat in the Council of the Governor-General of India. He left Singapore when his task was half accomplished, and handed over his government to a successor who did not sympathize with his views and reversed his policy. Colonel Vetch tells the story of this "new departure," and the subsequent outbreak which culminated in the Perak Campaign.

Whatever the precise reasons may have been, Sir Andrew accepted Lord Salisbury's no doubt flattering offer of the newly created office of Member of Council for Public Works in India; but the change proved of doubtful advantage: he went to India during Lord Northbrook's *régime* "anticipating" as Colonel Vetch writes "an expanding policy in Public Works which nobody could have directed better than himself. Instead, depreciation of silver, apprehension of famine, and frontier wars forced upon the Government of India a policy of severe retrenchment and economy during the whole term of his office." He found himself continually in opposition to Lord Lytton, who followed Lord Northbrook, and driven to play the part of Cassandra. Arriving in India in June, 1875, he at once perceived that the Governor-General's policy would inevitably land us in a war with Afghanistan; [to the writer of these lines he wrote during that year advising him to apply for employment in India adding "We are certain to have a war with the Amir of Cabul."] Again and again he urged Lord Lytton to face the facts, and, by the construction of lines of telegraph and railway while there was yet leisure, to prepare for a contingency which the policy of the Government was rendering a certainty. But Lord Lytton was as deaf to his entreaties in 1876 as Lord Hartington was to be in 1884 and the disastrous waste of millions on the transport in Afghanistan was only equalled by the money thrown away in attempting to rescue Gordon by the Nile expedition. Had Sir Andrew's advice been accepted and had the railway been begun in good time to the mouth of the Bolan Pass in 1877, and from Suakin to Berber in 1883, how different might have been the result!

Trojaque nunc staret, Priamique arx alta maneret.

The war in Afghanistan was essentially an Engineer's war—roads, railways, telegraphs, all were urgently needed: the demands on the R.E. in India during 1878–9 were enormous but Sir Andrew was equal to the occasion; he took care that the Corps was well represented, and co-operated with General Lumsden and General Roberts in selecting the fittest officers for the various commands. "You will of course," wrote Major-General Roberts, "nominate the R.E. officers for the several columns. The Commanding Royal Engineer I would prefer is Colonel Perkins . . . of all the junior officers I would prefer Captain Pierson."

Perhaps nothing in this biography shews more clearly how much in advance of his time Sir Andrew was, than his letter to Lord Rowton

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(then Mr. Montagu Corry) in which he unfolds his scheme for the creation (on the occasion of the first Imperial assemblage at Delhi) of a great Imperial Indian Senate.

"Take advantage of the present moment" (he is writing from Simla in 1876) "and give now to the princes and people of this country some recognition that they have a political and national existence. If done now you will consolidate and strengthen the English power in this peninsula, and call a true empire into life and vigour. . . . Extend to the nationalities of India the manifest responsibility of having a share in directing its destiny and you surround the Imperial crown with a triple line of defence."

That such an idea would meet with a sympathetic reception from Lord Beaconsfield, for whose eye it was of course written, was not unlikely; but we are not given Mr. Corry's reply. Lord Lytton we are told was not absolutely averse to the idea, but he shrewdly observed that if the people of India got their House of Lords they would undoubtedly want their House of Commons.

Sir Andrew returned home from India in June, 1880, after an absence of 7 years; he had initiated a great policy at Singapore and had borne a large share in the Government of India during a critical period of famine and war, but to the War Office authorities he was of course only known officially as a regimental officer awaiting employment, and although he had been Governor of the Straits and Member of Council in India he found himself nominated for the post of C.R.E. at Woolwich; but a vacancy occurring in the office of Commandant of the S.M.E. he was selected to fill it. Then came the "bolt from the blue." The appointment of Inspector-General of Fortifications became unexpectedly vacant in the following year, and was in the gift of the Secretary for War. Mr. Childers had once more, as on a former occasion, the good fortune to be able to select one of the candidates for the post from his own knowledge and experience of him. Clarke was not the senior colonel of those who had reasonable claims to the office; his fitness for it was undoubted, but there were such heartburnings as naturally occur when an unexpected promotion is made. "The appointment," in Sir George Clarke's words, "was sharply criticized," but it was more than justified by the result, and the efficiency of the office of the I.G.F. was strengthened in no ordinary degree by the boldness of the appointment.

Colonel Vetch has done full justice to Sir Andrew's career both as Commandant of the S.M.E. and as I.G.F. To officers of the Corps the chapters (X., XI. and XII.) which deal with this portion of his life will probably be read with greater interest than any others. This was the era of great developments; the extension of the Submarine Mining, the adoption of the Brennan torpedo, the entire revision of the imperial fortresses at home and abroad, and the protection of the mercantile ports, on all these points the Government of the day looked to Sir Andrew for advice and guidance; and they did not look in vain. His views were always clear and distinct. Whether he was reviewing the recommendations of the Royal Commission, or combating what he considered the mistaken opinions of a colleague at the War Office his advice was

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unmistakable and his minutes terse and telling: he was a progressive thinker and a fearless fighter: and no respecter of persons, whether they were Secretary of State or Commander-in-Chief.

Space will not allow of dwelling on Sir Andrew's latter years. He continued to represent the Colony of Victoria till the time of his death, but this work was only a part of his daily engagement; his activity to the last was astonishing. As his old friend Sir Algernon Borthwick wrote "We have worn well in the thirty years (since the days of the 'Owl' in '65) and are all young at heart and glad of each other's successes. Do you remember how we all said we should get on?" Throughout his long official career Sir Andrew had the knack or good fortune to be at hand at the proper moment: he was one of those who always "fall on their feet"; he recognized his opportunities and he did not let them slip. He joined the Government of Victoria at the very moment of the Gold discoveries and the grant of self-government; he went to the Admiralty at the instant when enormous works were being considered in consequence of the development of the ironclad fleet; he was appointed Governor at Singapore in the year Disraeli was calling attention to the Straits of Malacca which were then in a ferment; he was in India when the Afghan imbroglio made enormous demands on the R.E. resources, and finally became I.G.F. when the outcry was raised for more defences for our coaling stations and when great developments in fortification were projected.

"Sir Andrew," states Colonel Vetch in his final summing up, "made many friends and the friends that he made stuck to him through life, and he to them. . . . Those who knew the man, and differed from him condoned the extreme views he held on some points, because they were so eminently characteristic of him; and 'Andy Clarke' as he was called by his intimates, would not have been 'Andy Clarke' had not the vivacious spirit that displayed itself in a stimulating treatment of even ordinary subjects sometimes rushed into excess. A genial manner and a kind heart always ready to serve a friend were attractions that few could resist. As a public man he was an able and hard-working servant of the State."

Most readers of the book will, we think, find the last sentence hardly strong enough. Abilities they were of no ordinary kind, both heightened and deepened by a prescience which was rarely at fault even if it made his schemes seem to many to be the dreams of a visionary; his was that powerful characteristic of always being a little in front of the time, instead of lagging behind—a characteristic which, while it nearly always invites criticism, in the long run is usually appreciated for its unselfishness and justified by its results. To quote the words written of him by Mr. Chamberlain "he (Sir Andrew Clarke) had the great satisfaction of seeing his principles generally accepted, and he must have felt that he had contributed to their success. . . . This is, after all, the reward for which all honourable and conscientious public men most earnestly strive."

SPENCER CHILDERS.

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NOTICES OF MAGAZINES.

Engineering Record.

October 4th, 1905.

Reinforced Concrete Retaining Wall.—The design of the above, at the Baden Reservoir of the St. Louis Waterworks, is interesting, being of a similar style of work to numerous bridge abutments which have been built on the Wabash Railroad.

The wall proper is 24′ high, base to coping, tapering in section from 1′ thick at top to 2½′ at the point where it begins to splay into the foot. (The angle is filled up, and there is some cross reinforcement running through the foot of the wall at about 45° to the vertical). The buttresses are 15′ 9″ apart at centres and 2′ thick. (Actually these are not buttresses, but connecting members between the face wall and the foot). The foot is 15′ wide and 18″ thick. Coping is 39″ wide and 1′ thick.

Reinforcement consists of a grille of ¾″ to 1″ corrugated bars; in the wall proper the vertical series, which are on the puddle or tension side only, are spaced 1′ apart, and the horizontal series (on both sides) are spaced at 10″.

The footing contains a complete grillage one-third of the thickness through from the bottom. The buttresses or stiffeners contain a vertical series near the outer edge only.

The design is exceedingly economical in material as compared with an ordinary massive retaining wall; and seeing that this nature of design, where the weight of the mass retained can be brought on the flat foot to balance the overturning moment, is very advantageous, it seems that such walls are bound to be extensively used. They should be particularly suitable for defence works.

C. E. Vickers.

Nature.

November, 1905.

Survey of the Simplon Tunnel (*November, p.* 30).—Before the work of boring could be begun, three elements had to be determined with an accuracy in each case which must be greater in proportion to the difficulties of construction. These are the direction, the length, and the altitude above sea level. When the places of entrance and exit of the tunnel had been marked, the determination of these three elements began. That of the level is the least difficult, for by the aid of accurate instruments, it is possible to derive the difference in altitude of two stations 50 kilomètres apart with no greater error than 3 c.m. Several series of levels were taken, the mean showing a discrepancy of only 2 c.m., the

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actual difference of level between the two ends being 52·439 mètres. The second element, that of the length of the tunnel, was derived from triangulation; in this great accuracy was not required; the probable error was ±0·7 mètre, the actual length being 19,728·71 mètres.

The third element, that of direction, at all times presents some difficulty, but in the case of mountains, when local attraction enters as a disturbing factor, the problem requires very delicate treatment. In a tunnel 20 kilomètres long, an error in direction of one minute, which is the usual limit of accuracy, would produce an error of 6 mètres, and the tenth of such an error would be too great. Eleven well-defined cylindrical signal towers of brick were erected about 8 feet high, of which the axis was an iron tube. The theodolite was placed centrally over the middle of the iron tube, thus securing a solid support for the instrument and permitting accurate observation of the other stations. With the care exercised, the sum of the angles of any triangle ought to have differed from 180° by the known amount of the spherical excess; but the actual discrepancies were much larger, varying from 4 to 8½ seconds; these deviations were evidently due to the attractive force of the mountain, which sensibly displaced the direction of the plumb line. This deviation at the north end was found to be 14″, at Rosswald 24″, and at the south end 6″.

Assuming these deviations from the vertical to arise from the attraction of the mountain mass, it was found possible to reduce the closing errors of the triangles very materially, so that the direction of the tunnel could be fixed with a probable error of only ±0″·7. This turned out most satisfactorily; the wall of the north tunnel was absolutely continuous with the wall of the south tunnel, though the observations had been impeded by curious refractive effects akin to those seen in a "mirage." These disturbing effects were most noticeable when observing towards the north end of the tunnel, where the difference of temperature between the internal and external atmosphere was greatest.

The meeting of the galleries with such accuracy is chiefly due to Dr. Rosenmund, of Zurich.

MARTIAN METEOROLOGY (*p.* 38).—A number of photographs taken with the 13-inch Boyden telescope at Cambridge (Mass.) in 1888, and again in 1890 with the same instrument at Mt. Wilson, California, show sufficient variation, due to meteorological changes, to prove the existence of an effective atmospherical circulation of moisture on Mars. On two occasions the height of the clouds above the Martian surface was measured, giving about 15 miles as the result; and Professor Pickering suggests that the existence or non-existence of such clouds in the equatorial regions may account for the discrepancies noted between various estimations of the amount of the polar flattening and also for the observed transfer of precipitation, during the Martian year, from pole to pole. On May 19th, 1905, the north polar white (ice) patch was first observed 126 days after the summer solstice; in 1903 the first frost effects were observed 128 days after the solstice.

W. E. WARRAND.

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U. O. L. DUPLICATE

THE ROYAL ENGINEERS JOURNAL.

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This Rangefinder is constructed largely of Aluminium and is covered externally with brown leather. It is fitted with pads on the ends to prevent damage by rough handling. It is supplied in a strong leather case, as shown, fitted with a shoulder-strap.

The tripod shown in the illustration is not supplied with the instrument, as the Rangefinder is so constructed that it can be used with ease without a stand.

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DOUBLE TOOL CART EQUIPPED FOR FIELD TROOP, R.E.
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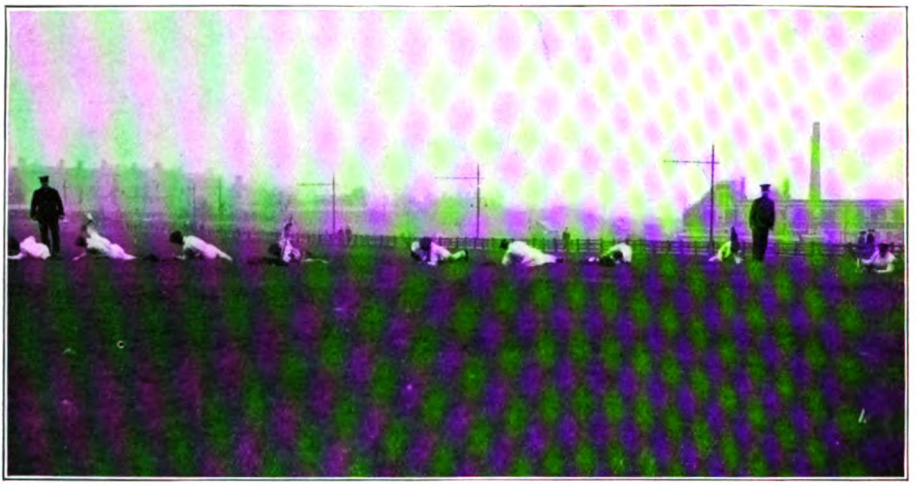
ENTRENCHING UNDER FIRE.



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1 2 3 4 5 5 6 6 7 8

1 2 3 4 5 5 6 6 7 8 9

1. Adze-shaped tool, No. 1.
2. Nigerian tool.
3. Adze-shaped tool, No. 2.
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7. Pear-shaped adze.
8. Beatt's implement.
9. Blair's combined pick and shovel.

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ROYAL ENGINEER DUTIES IN THE FUTURE.

By Bt. Col. E. R. Kenyon, R.E.

As all important Barrack Construction work and all Hospital work at home stations have been, or are being, transferred to the new civilian Department, it is sometimes asked what work there will be for R.E. officers at home, especially for the seniors.

It is well known that very many R.E. officers urge that barrack repairs ought to be undertaken by the construction department, on the grounds that it is uneconomical to employ two staffs for building duties, that it is not right or economical to let one department erect buildings to be maintained by another which has had no voice in deciding the materials and methods of construction used, and that the repair duties occupy a great deal of the time of officers and non-commissioned officers while giving them little or no training of practical use as a preparation for war. If this view prevails it is obvious that the question of how the time of R.E. officers is to be usefully employed becomes still more prominent.

It seems to me, however, that the question really arises from the habit, which has been formed during long years of construction and repair duties, of looking upon building work as the primary duty of the Royal Engineer. In reality it has never been so. His primary duty in peace is the same as that of any other soldier, namely preparation for war. Building duties have been given to him on financial grounds, because it was considered wise in the interests of economy to employ on public works in time of peace the large number of R.E. officers and men who must be maintained for war purposes. This policy is now reversed; and this has led some people to think that consequently there will not be enough work to occupy the time of Chief Engineers, C.R.E.s, and the officers and non-commissioned officers under them. This is in my opinion an entire mistake.

There is one great duty which hitherto we have never had time to perform properly, namely the thorough study of our own Districts or Divisions from a military point of view. Is there any C.E. or C.R.E. who is fully conversant with every road and railway, every village and town, every hill and valley, in his district; who has had complete road reports prepared and filed in his office; who knows all the possible defensive positions, the routes of advance against possible invaders, the best lines by which to concentrate, the available railway resources, the possibilities of extending existing railways so

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as to facilitate coast defence, the best camping grounds, the means of providing water supply, etc., etc. ? On all these matters we can find plenty of occupation for a long time to come, and might be of great service to the Intelligence Department.

Again, in how many Districts has it not been the case that when additional officers are wanted in the summer as umpires, for staff rides, etc., the R.E. officers were "not available ?" I think not only that every effort should be made by every C.R.E. to ensure that he himself and his officers are always available for such duties, but also that he should make a point of offering their services to his General, until the habit has been formed of looking on the R.E. as a valuable reserve from which the ordinary training staff can be expanded.

How often we find it difficult to provide the instructors who are being increasingly asked for by cavalry and infantry for their classes of officers and non-commissioned officers. Yet this is a most important duty, and one on which Generals and Commandants of Schools are most ready to welcome all the help we can give. We, in our turn, should gladly seize every opportunity of giving such help.

Much remains to be done in the development of systems of communication suitable for use on the march and in battle. Telegraphs, both wire and wireless, telephones, etc., have to be studied, experimented with, and developed. The training season gives great opportunities for such work.

The entraining and detraining of troops at extemporized stations have to be prepared for; and it is probable that at places where there are railway lines used only, or mainly, by W.D. traffic, practice might be obtained during the training season.

One more point I should like to emphasize is the duty of studying sanitary questions. I am afraid that in times past some of us have rather looked upon the medical officer as a terrible nuisance, who is always "asking for more" in the way of prevention of possibilities of disease; and this has arisen from the fact that the medical requests entail great inroads on our time and on the funds at our disposal. Yet good sanitation is of enormous military importance both in barracks and in the field; and it is essential that every military engineer should be able and willing to co-operate with the medical officer in providing for the sanitary services on the march and in camp, cantonments, and barracks. I include barracks, because, though we shall not build them at home for the present, we may during campaigns abroad have to improvise and occupy them.

The above outline sketch of duties would apply to every R.E. officer in greater or less degree according to his rank. But in the Fortress and Coast Commands there are the added duties of fortification, involving minute study of every possible form of attack and defence, of all the means of extending and organizing defensive works, of facilitating the movements of troops, the methods to be adopted

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for opposing landings of large or small bodies, etc., etc. Also in all Coast Districts practice should be obtained in arranging for embarking and disembarking troops of all arms.

A very slight consideration of these duties will convince most people that the posts of Chief Engineer of a Command or a Fortress and of C.R.E. of a District should be no sinecure in the future; and that, far from finding it difficult to give work to their subordinates, their trouble will be to decide the order in which all the duties are to be taken up and to so arrange them that there may be time for their execution, for the due performance of all other military duties, and—a very important matter—for systematic and regular study of their profession. It is utterly wrong that—as has hitherto so often been the case—the time of an officer should be so fully occupied that he has no opportunity for study of military history, for working out military problems, and for making himself acquainted with the organization, duties, and working of the other arms and branches of the service.

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ORGANISATION OF ROYAL ENGINEER UNITS FOR EMPLOYMENT WITH CAVALRY.

By Capt. C. de W. Crookshank. R.E.

THE whole question is a comparatively new one, and had its inception in the "Mounted Detachment" which, during the late South African War, developed into 4 Field Troops of which 3 still exist. The title Field Troop is redundant and was presumably adopted in the first instance for want of a better; at that time the Corps possessed other troops (namely Pontoon and Telegraph), but these are now designated companies so that the term "Troop" would now be ample, its Field nature being implied.

The requirements of the Army are for 4 Cavalry Brigades and for a considerable mounted force in South Africa, equivalent to 2 Brigades. At the same time everyone will agree that on the score of expense a large number of R.E. Troops cannot be maintained, particularly as with their present establishment it is tantamount to keeping a number of Sappers doing little else than grooming horses and routine military duties, with practically no opportunity for getting on the works and keeping up their trades.

This Trade question is a particularly important one, and I submit that for the Cavalry arm it is necessary to have a few Sappers with high qualifications; my reason being that, as Cavalry will more than ever have an independent *rôle* in warfare, working either in screen or in detached masses, and will consequently operate principally at considerable distances from the main Army, the Engineers with it must perforce be entirely self-supporting and must be capable of carrying out any jobs in Telegraphs, Railways, and General Engineering that may present themselves, until the Special R.E. Units of the main Army can take them over or necessity ceases.*

To assist in this and to realise economical working, Cavalry Pioneers must be made more use of. These require more training and encouragement; but outside England, where Classes and the Annual Field Troop Camps offer opportunities, little has been done, and the Pioneer exists virtually in name only. Furthermore, they have no technical vehicles for the carriage of tools, pumps, etc., and with the abolition of wallets their last chance of carrying a few explosives (under very dangerous conditions) has disappeared.

* Examples of this were frequent during the late South African War.

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I am consequently led to make the following suggestions for the proper organisation of R.E. Units for the Cavalry arm:—

The present Field Troops should be reconstructed as 3 Squadrons, R.E. (lettered A, B, C), each consisting of a Headquarters and 2 Troops (A and B); one Troop to be the normal R.E. Unit for a Cavalry Brigade. This will give the requisite War Units for 4 Brigades at Home and for the Force in South Africa; and will furnish Peace Units of better proportions than the existing ones (1) for command and training, (2) for employment on "Works." The units would be organised with ranks, etc., corresponding to those of Cavalry, and adapted for the accommodation of its Pioneers in Peace and War.

ESTABLISHMENT OF PROPOSED SQUADRON, R.E.

I will first work through this in detail for officers, personnel, riding horses, and trades, and thence deduce the establishment of vehicles and draught horses required.

The strength under these heads is for "Higher Establishment"; these Units should be kept at such in Sapper personnel, as trained mounted Sappers cannot be satisfactorily produced at short notice (good tradesmen are rarely handy horsemen and *vice versâ*); any peace reductions to produce "Lower Establishment" economies should only appear in draught, personnel, and horseflesh.

Officers.—1 Major, 1 Captain, 3 Subalterns (1 extra to be added on mobilisation).

Officers' Horses.—10. Two horses per Subaltern are necessary in these units; there seems no reason why the R.E. Subaltern should be the only combatant officer in a Cavalry Brigade not allowed 2 horses in Peace Establishments.

Headquarters.—*1 Squadron Sergeant-Major, *1 do. Quartermaster-Sergeant, *1 Farrier Sergeant, 1 each Pay, *Wheeler and Saddler Corporals, *2 Trumpeters.

Horses for above.—6 (for those marked *).

*Each Troop.**—2 Sergeants, 3 Corporals or 2nd Corporals, 3 Lance-Corporals, 1 Shoeing and Carriage-smith (farrier certificate), 24 Sappers.

Horses for above.—24.

* The N.C.O.s detailed include 3 for the draught establishment. In a mounted unit like this, I am confident it is far better to eliminate the differences which at present exist between the mounted and dismounted branches of the Corps, and which are difficult to avoid in Field Companies and similar units having mounted ranks for Transport duties only.

Draught Section N.C.O.s should, where all are mounted, take their place and assume responsibility according to rank and without prejudice, and the system improves their status and minds and works satisfactorily (*c.f.* the Telegraph Companies, R.E.). The Senior N.C.O. on any occasion (whether sapper or draught branch), while responsible for the whole party, takes in detail responsibility for "work" or "horses" after distribution.

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Trades (*each Troop*).—5 Telegraphists (3 office, 2 permanent line), 4 Engine Drivers (2 locomotive, 1 road, 1 stationary), 2 Fitters, 2 Smiths, 6 Carpenters, 1 Wheeler, 1 Saddler, 2 Bricklayers and Plasterers, 1 Plumber. Total—24.

As regards Trades, I have selected the most suitable ; and of these the most important are the Telegraphists and Locomotive Engine Drivers. With this strength in Telegraphists a cable cart can and should form one of the technical vehicles of each Troop, which can then be in a position to put through damaged lines or keep its Cavalry Brigade in cable connection with the main Army and to work lines (covered by the Cavalry only, in wide movements), under ordinary conditions without being dependent on Telegraph Units (whose hands will be full) to detach parties. Personal experience during the past two years with a Cable Section added to the Field Troop under my command, in addition to Telegraph experience in war, convinces me of the importance of this arrangement, which is after all only slightly increasing and employing to full value the establishment of Telegraph Trades laid down for a Field Troop and giving them the mobile vehicle necessary to carry out their work.

Locomotive Engine Drivers do not, I believe, figure in the Trades at present authorised ; but their necessity in a Troop requires no comment. The Director of Railways and the Field Troop Commanders during the late war will, I feel sure, agree.

A summary of the detail given so far furnishes therefore a Squadron R.E. of the following strength :—

	Personnel.		Horses, Riding.
Headquarters	Officers	5	10
	Staff Sergeants	2	8
	Artificers and Pay Staff	4	
	Trumpeters	2	
	Sergeants	4	66
	Corporals and 2nd Corporals	6	
	Lance-Corporals	6	
	Farriers (S. & C.S.)	2	
	Sappers	48	

Total :—Officers 5 ; Other Ranks 74 ; Horses :—Officers 10, Riding 54.

This will not be found to be a large increase on the present Sapper Establishment (War) of a Field Troop. It supplies, however, 2 Troops for War, Manœuvres, and Training ; and, in virtue of an increase in men and a reduction (*pro rata*) in horses, will enable a Squadron to employ its 2 Troops in peace time on the "works" or in "stables" alternately, complete as such, which is the only satisfactory solution of the troublesome question of horse Sappers.

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It may be suggested that the strength of a Troop is now insufficient for a Cavalry Brigade, but I propose making this good by employing the Pioneers of the regiments forming the Brigade to which the Troop is affiliated; and for this purpose 2 N.C.O.s and 6 men from each regiment, making 24 of all ranks, should be attached for Manœuvres, Training and War. In the event of a Regiment being temporarily detached for special duties, its Pioneers and a proportion of the Troop Sappers should accompany it with a pack horse and tool waggon. This brings us to the question of the Establishment of Vehicles.

ESTABLISHMENT OF TECHNICAL AND OBLIGATORY VEHICLES, DRAUGHT AND PACK HORSES, AND DRIVERS FOR A SQUADRON, R.E.

FOR EACH TROOP.

Description.	No.	Horses. Draught.	Horses. Pack.	Remarks.
Tool Waggons	3*	18	—	*1 extra for Pioneer Troop.
Cable do.	1	6	—	
Boat do.	1	6	—	
G.S. do. for Spare Cable, etc.	1	4	—	
„ „ Technical Stores	1	4	—	
Forage Cart	1	2	—	2nd Line, horsed, etc., by Army Service Corps.
Water do.	1	2	—	
Pack Animals for Technical Stores.....	—	—	3	
Totals	9	42	3	

For all ordinary peace requirements, however, teams are only required for :—2 Tool Waggons, 1 Cable do., 1 Boat do., and 1 G.S. do. (for spare Cable, etc.).—Total 28 horses. Making a total for the Squadron of 56 draught horses, 6 pack horses, and 18 vehicles.

To cover all requirements, a strength of 46 drivers would be necessary, resulting in a Summarised Establishment for a Squadron, R.E., of :—

	Per Squadron.	For 3 Squadrons.
Officers	5	15
Rank and File	120	360
Horses, Officers	10	30
„ Riding	54	162
„ Draught	56	168
„ Pack.....	6	18

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If compared with a total for 6 Field Troops required under the present organisation, this shows a saving in favour of the present proposals, without considering other advantages.

As, however, there is no immediate necessity for keeping 3 Squadrons on the "Higher Establishment," a suitable "Lower Establishment" can easily be produced by a reduction in horses (riding, draught, and pack), and consequently in the Draught Branch ranks, to that required for the Headquarters and 1 Troop, which gives—

"LOWER ESTABLISHMENT" SQUADRON, R.E.

		Remarks.
Officers	4	(1 Major or Captain, 3 Subalterns).
Rank and File ...	98	(less 2 N.C.O.s, 20 Drivers).
Horses, Officers...	8	
„ Riding ...	30	(Headquarters 6, 1 Troop 24).
„ Draught...	28	(1 Troop).
„ Pack	3	do.

Such a reduction would not result in any loss of efficiency as the Establishment is complete in every detail for peace training and work, and the Unit is readily made up to a "Higher" state by the addition of an officer and of draught ranks and horses.

One Squadron on the "Higher Establishment" for the Aldershot Army Corps and two Squadrons on the "Lower Establishment," one at home and one in South Africa, should thus settle the Cavalry requirements in R.E. Units at a total of:—

Rank and File	316
Horses, Riding	114
„ Draught	112
„ Pack	12

and this is, I am sure, the least strength which should be maintained in order to ensure good results.

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APPENDIX.

TOOL WAGGON FOR FIELD TROOPS.

The accompanying photo shows one of the Tool Waggons which I have improvised for use in the 2nd Field Troop. (Owing to a faulty shutter the lead and centre pairs were fogged on the plate, and have been stippled out so that the Vehicle appears with only wheelers in draught).

The limbers are the ordinary Pom-Pom limbers, with slight alterations to the boxes. The waggon bodies were made up from some vehicles brought out by the Electrical Engineer Volunteers for Search Light work in the late war, but which had to be considerably modified and altered to produce the present article.

The weights are—

Packed	Limber	13 cwt.	Total 32 cwt.
„	Waggon	19 „	
Empty	Limber	9 „	„ 18 „
„	Waggon	9 „	

The wheels at present used are 3rd Class B. 158, and seem to answer well, though they might possibly be made slightly heavier; but as South Africa is so much harder on wheels than home, this point is not serious.

The vehicle has ample clearance, a defect which, to my mind, makes the ordinary R.E. Double Tool-Cart quite unsuited to cross-country work. Having come out well after full and most exacting trials over all varieties of rough country and at all speeds, the design seems not unlikely to furnish a pattern which should meet all requirements for Cavalry use.

I add Loading Tables, which detail the contents answering local requirements; but as different conditions demand different stores, they are not submitted as "hard and fast" examples for adoption.

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2ND FIELD TROOP, R.E.

TOOL WAGGON EQUIPMENT.

(Loading Tables).

Description.	No.
LIMBER (FRONT BOX).	
Brushes, carriage	1
Pliers, wire cutting	3
,, side ,,	3
Tapes, measuring, 100 ft.	1
,, tracing	2
Spanners, hose pipe	2
,, McMahon, 15″	1
Pins, lynch	2
Augers, screw, ¼″	1
,, ,, ½″	1
,, ,, ¾″	1
,, ,, 1″	1
,, ,, 1½″	1
,, ,, 2″	1
Handles, auger	3
Bevel steel blades, 12″	1
Buzzers, wheeler's	1
Awls, brad, blades	3
Handles for do.	3
Chisels, firmer, 1½″	1
,, ,, 1¼″	1
,, ,, 1″	1
,, ,, ¾″	1
,, ,, ⅝″	1
,, ,, ½″	1
,, ,, ⅜″	1
Files, saw, ¼ sq., 5½″	5
Handles for do.	1
Gimlets, common	3
,, spike	1
Hammers, 24-oz.	1
Knives, dressing	1
Lanterns, folding	2
Mallets, carpenter's	1
Pincers	1
Pencils, carpenter's	3
Pins, draw, bore 12″	1
Punches, carpenter's	1
Saw, hand, 26″	1
,, turning	1
,, tenon	1
Spokeshave	1
Square, carpenter's, 9″	1
Screwdriver, 12″	1
Stones, oil	1
Wedge, boxing	1
Planes, jack	1
Chalk, white ..... lbs.	1
Bags, carpenter's	1
Bucket, leather, male and female, for L. & F. pumps	2
Washers, leather	6
Drag Washers	2
(EXPLOSIVES).	
Caps, commercial (100) ..... boxes	1
Detonators, No. 8, cylinders	2
,, ,, 13 ,,	1
Bags, guncotton	2
Primers, 1-oz, boxes of 5	10
,, 2-oz. ,, 5	3
Matches, Vesuvian ..... boxes	1
Slow match ..... piece	1
Fuse, safety ..... box	1
Tape, india rubber ..... ,,	1
LIMBER (REAR BOX).	
Axes, hand	3
,, felling	5
,, handles, spare	2
Blocks, brake	2
Hammers, sledge, 14-lb.	1
,, miner's boring, 7-lb.	1
,, mason's spalding	1
,, stone breaking	3
,, handles	3
Hooks, reaping, large	3
Hose, canvas, 40-ft.	1
Saw, hand, 26″	1
Stone, grinding, G.S., 10″	1
(EXPLOSIVES).	
Fuse, instantaneous ..... box	1
Guncotton* ..... ,,	1
,, Cavalry ..... ,,	1
Ammunition, S.A., ·303 ..... ,,	1
LIMBER (OUTSIDE EQUIPMENT).	
Bars, crow } or on the Waggon	2
,, boring } Trail.	1
Ropes, picketing, 80-ft.	1
,, drag, large	2
Swingle trees, spare	1
Traces, rope, A.S.C. harness	1
Poles or Bars, breast	1
Boxes, grease	1
WAGGON (FRONT BOX).	
Lines, Hambro	4
Lashings	4
Pickets, 2′ 6″	54
WAGGON (REAR BOX).	
Axes, pick, head	30
,, helves	45
Mauls, G S.	2
Shovels	15
Spades	15
WAGGON (OUTSIDE EQUIPMENT).	
Pumps, lift and force, with 2 lengths delivery and 1 do. suction hose complete	1
Handles, pump	2
Troughs, canvas (2,300 gal.)	2
Ropes, trough	2
Buckets, leather (water)	2

* As required.

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ENTRENCHING UNDER FIRE.

By Bt. Lt.-Col. G. M. Heath, d.s.o., R.E.

Recent experience shows that the infantry soldier must carry on his person some sort of entrenching tool. Tools carried on pack animals or in carts may not always be available when most required, that is when attacking infantry are brought to a standstill by the intensity of the enemy's fire.

In selecting a portable tool a choice must be made between three alternatives :—

(1). A combined pick and shovel, weighing 3 to 4 lbs., designed for all purposes, as carried by us before the South African War.

(2). A light pick carried by one man and a light shovel carried by another, as in the Japanese and some other armies.

(3). A very light implement, weighing 1½ to 2 lbs., carried by every man, and good enough to enable him to scrape a hole for himself whilst *lying down* under fire; to be supplemented by full-size tools, carried on pack animals or in carts, for use when circumstances permit, *e.g.* at night.

The combined pick and shovel has been tried, but was discarded as unsatisfactory after the South African War. A large number of such implements have been devised from time to time; as a rule, they appear to be too small and weak for serious work, while unnecessarily heavy for use under fire. The weight adds considerably to a soldier's burden and experience proves that such a tool is apt to be thrown away.

Useful, and at the same time light, tools can be designed under class (2); but these suffer from the serious objection that the man carrying the pick is likely to get separated from the man carrying the shovel.

Implements of class (3) have been tried from time to time at Chatham, notably a trowel invented by Sir Richard Harrison and improved by Colonel L. C. Jackson, and more recently various adze-shaped tools designed by the Fortification School. It appears that in ordinary soil practically as good results can be obtained, lying down, with the last-named implements as with the heavy varieties;

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they are very light and every man can carry one; while for serious work not under fire the heavy tools will be available.

The last system would seem to be the best of the three; but the whole subject requires ventilation.

Experiments with various tools have been carried out recently at Chatham. The three photographs in the frontispiece show the work done in half an hour in ordinary soil; the uppermost shows the men commencing to dig, the centre the progress about half-time, and the lowest the party covered from view. There was little to choose between the various implements mentioned on the photographs. The parapets at the end of the half-hour were only about 1 ft. 6 in. thick, and would have kept out a good proportion of bullets; but another quarter-hour's work would have been sufficient to provide the protection required.

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SOME NOTES ON THE MODERN COAST FORTRESS.

By Col. T. Ryder Main, c.b., R.E.

These notes make no pretence to teach the whole duty of the military engineer with reference to the defence of a modern Coast Fortress. They are notes and nothing more.

My only excuse for writing them lies in the fact that, at the present time, much thought is being given to this special type of defence, owing to the lessons of the Russo-Japanese War; and that I, as Chief Engineer of the Portsmouth and Portland defences, have had opportunities of discussing and considering the various changes and modifications that the lessons of that war are forcing upon us.

I propose to omit, as far as possible, the general descriptions to be found in the text-books and elsewhere, and to dwell rather on novel views. These views, as expressed, must be taken as my own, and may not be concurred in by everyone. Their consideration can do no harm and may do good.

Responsibility for the Defence.

On the declaration of war the primary duty of a Navy so powerful as ours would be the seeking out of the enemy's fleet, with a view to its destruction. To do this satisfactorily the Navy should have its hands free, and it should not be hampered by having to look after the defence of its "bases"—strong fortified ports, where its ships could be repaired or replenished with coal, ammunition, provisions, and men. On this account it is usual in the British Service to provide "fixed" defences at these ports, and to intrust the land forces with their design in times of peace and their manning in times of war. The relative advantages and disadvantages of this system have been much discussed. On the one side it has been argued that as the Naval bases are solely for the use of the Navy, who are specially acquainted with the methods of attack that are likely to be used by ships, it were better that the Navy should also take charge of the fixed defences; whilst on the other side it is argued that the Navy in time of war will have quite enough to do in "blue water" without frittering away their time and opportunities in operations on land, and further that the defence of a coast fortress may be from the land as well as the seaside, as was exemplified in the recent attack on Port Arthur.

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Under present arrangements, as stated, our Army is primarily responsible for the defence of the coast fortresses, but still both Services must co-operate in carrying out the details of any scheme. As instances of questions which require mutual consideration we may mention—(i.). The regulations for the examination service and the passing in and out of the port of friendly vessels. (ii.). The transmission to the Fortress Commander, as soon as possible, of intelligence from Naval sources as to the whereabouts of the enemy's fleets or ships. (iii.). Arrangements with the Naval officer in charge of the local submarine and torpedo craft, whose sphere of operations would, as a rule, be immediately in front of the fixed defences.

Many other mutual arrangements, which will be necessary, will no doubt suggest themselves to one's mind; and this necessity is provided for in most modern coast fortresses by the formation of a permanent joint Naval and Military Committee, which the Commander of the Fortress, as President, can assemble, from time to time, as he considers necessary, whether for the purpose of preparing for war in times of peace, or for carrying on a successful defence during war.

TYPE OF DEFENCES.

The type of defence to be adopted in a coast fortress will depend on :—(A) the nature of attack that may be expected; (B) the local conditions of the port; and (C) the strength and nature of the garrison that is likely to be available.

I do not propose to deal with the question of defence against attack from the land side, nor do I propose to take into account the amount of assistance that may be obtained from the defenders' own Naval forces, as this latter may, at any time, cease to exist either permanently or temporarily.

(A). NATURE OF ATTACK THAT MAY BE EXPECTED.

Any modern scheme of defence for a coast fortress in Great Britain will have to consider the following forms of attack, and each form may be combined with one or more of the others, the one form being often employed as a blind or feint with the object of giving a better chance of success to one or more of the others :—.

(*a*). The attack by torpedo craft at night.
(*b*). The attack by submarine or submersible vessels by day.
(*c*). Bombardment by large war vessels.
(*d*). Blocking operations, by sinking vessels in the fairway, where harbours have narrow mouths or artificial entrances.
(*e*). The laying of mines to prevent ingress or egress from the port.

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To explain these attacks more in detail :—

(*a*). All our harbours, and especially those on the Southern or Eastern Coasts, are liable to attack by torpedo craft by night, which may be expected immediately on, or even prior to, the declaration of hostilities. This latter fact is fully recognized in our modern defence schemes, and steps are taken to meet such attacks accordingly. It is the most likely form of attack nowadays, offering as it does a chance of producing far-reaching advantages for the attacker with very little commensurate risk.

(*b*). The landsman cannot assist to any great extent in beating off an attack by submarines or submersibles, and it would not therefore be likely to affect any of his schemes of defence.

(*c*). As regards bombardment by large warships I cannot do better than quote from *Garrison Artillery Training*, Vol. I., 1905 :—"The attainment of sea command being the vital issue, an enemy will rarely be prepared, before that issue has been determined, to risk the loss or the crippling of a portion of his battleships or cruisers by exposing them at effective ranges to the fire of shore batteries. The recent development of torpedo craft and submarine boats have, moreover, much enhanced the risk incurred by battleships and cruisers in delivering an attack on a port in which such craft may be stationed."

Still the unlikely may happen, and has happened before now, and the object of coast defences is to prevent such possibilities. Fog has to be specially considered in our English climate in connection with this and many other forms of attack; and there are many positions which war vessels could take up in the vicinity of our modern coast fortresses, in which they could not well be fired upon in thick weather, and from which, nevertheless, they could in a short time produce a very telling effect on a dockyard or on ships crowded together in a harbour.

In these days of wireless telegraphy the movements of all warships will be pretty accurately known to both sides, and the fact that our ships may have been called away for a time to concentrate at a certain point may tempt a few armoured cruisers of the enemy to appear before a port, to which our fleet cannot return for say 24 hours, and, after delivering a rapid and telling bombardment, to get away again before they can themselves be punished.

(*d*). Some of our harbours are specially open to blocking operations, on account of the narrowness of the natural ships' channel at their entrances, and some on account of the narrow passages through artificial breakwaters. The Japanese in the late war, as is known, made many unsuccessful attempts to block the entrance to Port Arthur; but they would probably have met with more success if they had had at their disposal some of those old battleships and cruisers which we are now throwing away. Such vessels would stand a lot of knocking about from shore batteries at night (especially as the

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heavy guns of those batteries would probably have no auxiliary lights) and would, if sunk in the fairway of the harbour's entrance, possibly prevent ingress or egress of warships for many weeks.

(*e*). Attack by mine-laying (if attack it can be called) evidently bears but little on the question of "fixed" defences.

(B). THE LOCAL CONDITIONS OF THE PORT.

The siting and nature of the fixed defences of a port must, of course, be much influenced by its local conditions; and hence a good sea chart and contoured map of the surrounding country is an absolute necessity to the designer of coast defences, who must also have an accurate knowledge of other details such as the rise and fall of tide, the strength and nature of currents, etc.

(C). THE GARRISON THAT IS LIKELY TO BE AVAILABLE.

It is not necessary to dilate much upon this self-evident fact that the design of the defences must be much influenced by the numerical strength and value of the troops that can be allotted to them. Where skilled troops are plentiful a type of defence may be entertained which would be quite out of place where many such troops could not be supplied.

DEFENSIVE MEASURES AGAINST THE DIFFERENT FORMS OF ATTACK.

Let us now consider how the different forms of attack can be met with the greatest probability of defeating them.

ATTACK (*a*).

Attack (*a*) by torpedo craft will be delivered at night; and therefore it is imperative for the defender to have a considerable portion of water area well illuminated to allow of the anti-torpedo-boat guns stopping all hostile vessels that attempt to pass them. Remember that these guns are at all times practically useless unless there are ample lights to assist them.

The usual arrangement, where local conditions so permit, is to have an outpost line and inner defences so arranged that the gun resistance and lighting become stronger as we gradually approach the entrance of the port in which the friendly ships can lie behind a strong boom.

To warn the guns many look-outs are employed, and these, on detecting the presence of a hostile boat, can ring alarm gongs at all the Q.F. gun groups, and can communicate by telephone with the different Fire Commanders. Remember that the control of fire of the Q.F. anti-torpedo-boat guns is in the hands of the Gun Group Commander and is not controlled by anyone else.

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On defence lights and their details I will only touch lightly in these notes. They are fully described in Major Baker Brown's pamphlet "Electric Lights for Coast Defence."

I think that more attention, than is usual, might be given in the modern fortress to the question of protecting the lights both from raiding parties and from the hostile fire of boats, and that the lights should have more spare projectors and engines than at present. Our present system of lighting is run on such an economical scale that if one light is out of action for even a short period a very awkward unilluminated area is formed at many vital points.

The old question of the control of the electric lights crops up again from time to time. I noted the following remark in the 'Highly Commended' Duncan Essay for 1905 by Major H. B. Wood, R.G.A.:— "In home waters the control of the electric lights is at present vested in the hands of the R.E." Now this is scarcely correct. The control of the electric lights is, by official instructions, in the hands of the Section Commander and he can delegate that power to whomsoever he likes, provided he bears in mind the general instructions to the effect that artillery fire at night will be assisted by "fixed" beams only, and that although "search" lights may sometimes be employed for the purpose of discovering the movements of an enemy's ships, they will only *under exceptional circumstances* be used for following or fighting them by artillery fire. Peace manœuvres have shewn that nothing aids the passage of hostile boats more than putting the control of gunfire and lights into the same hands. The R.E. with their lights assist the R.G.A. with their guns in the defence of a coast fortress in somewhat the same way as the R.F.A. assist the infantry in the attack of a position, but no one would advocate the control of field guns being put into the hands of the brigadiers of infantry. Major Wood adds in his essay "All appear to agree with the principle that electric lights and guns should be under one head." Quite so, but that head should not, primarily, be the R.E. or the R.G.A., but the Section Commander, who is responsible for the defence of the whole section.

The inner lights should not as a rule be exposed continuously; they should be "damped" until the alarm circuit gives warning of the approach of a hostile vessel; and it would appear that the look-outs on that circuit should have the power of warning the lights as well as the guns, which is not the present arrangement.

Owing to the necessity of constant peace practice with the lights their positions are probably well known to all foreign powers, and it would appear advisable to arrange in peace time for certain extra lights to be erected on mobilization so as to act as false guides to an enemy's vessels, and so possibly run them ashore. Naval men, who have had experience of the difficulties of handling torpedo craft in the glare of electric lights, specially advocate the use of such false lights.

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The effective range of electric lights *as regards the laying of guns* is generally much overstated in the text-books. In considering defences those distances may well be lessened by 30 to 50 per cent. Attack (*a*) is not likely to be delivered in England on a night that would allow of the maximum effective range of the lights.

The present anti-torpedo-boat guns are for the most part of the 12-pr. Q.F. type. It is doubtful if these guns are sufficiently heavy to stop a modern destroyer, and it is probable that many of them will have to be replaced before long by others of a heavier type. 6-prs. give no commensurate return for the manning numbers required to work them.

ATTACK (*c*).

Attack (*c*), or bombardment by war vessels, will probably never take place as long as vessels cannot carry it out without the risk of receiving considerable punishment themselves; but this fact points at once to the necessity of having guns of sufficient calibre placed well to the front to prevent hostile vessels from getting into positions from which they could bombard satisfactorily. It is stated that Admiral Togo, after some experience before Port Arthur, issued a general order that none of his vessels were to approach within 12,000 yards of the guns of the defence. He would not have been compelled to exercise this precaution unless the Russians had mounted powerful guns to oppose him.

In modern designs therefore we aim at pushing our heaviest guns (9″·2) to the front to fire on all waters there in which big war vessels can manœuvre, and at removing them from interior waters into which, in the present day, such vessels could not penetrate.

There seems to be but little likelihood of a heavier gun than the 9″·2 being used for coast defences. The reason for this was explained by Major-General D. D. T. O'Callaghan, C.V.O., President of the Ordnance Committee, in a recent number of the *Royal Artillery Journal*. The projectiles of the 9″·2 gun are about the heaviest that can, on an emergency, be man-handled; and the expense and complications of a 12″ barbette mounting would be so great as to render the employment of so heavy a gun improbable, in the immediate future at any rate.

It has been advocated by some that the medium guns (6″) should be done away with altogether, as being useless against modern armoured vessels. I do not concur in this view, because:—(i.) there are many parts of a modern war vessel of the 1st class that are unarmoured, and, if we are to believe newspaper reports, Admiral Rozhdestvensky has stated that at the battle of the Sea of Japan his vessels suffered more from the fire of medium guns amongst the *personnel*, etc., than from that of the heavy guns; (ii.) it is important to have some medium guns in the front line to act as auxiliaries to the 9″·2 guns by

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drawing off the enemy's fire from them whilst they are going through the comparatively slow process of loading which is inherent in them.

The use of high-angle-fire guns has to a great extent gone out of fashion. They complicated the defence and required considerable manning parties; but they would be very useful against attack (*c*) and I, for one, am not convinced as to the advisability of doing away with guns which can be worked by comparatively unskilled men, and which cannot be themselves silenced.

ATTACK (*d*).

Attack (*d*), or the channel-blocking attack, is a difficult one to meet satisfactorily. Such an attack would certainly be made at night and probably in conjunction with attack (*a*). There is considerable difficulty in sinking an old armoured vessel by gunfire before she can get to her goal, and this is specially difficult at night when, as at present, the heavy guns have no lights to assist them.

The best arrangement probably is, as far as possible, to deny all passages except one to approaching vessels and to have considerable gun power on that one.

It is probable that extra lights will have to be added to our present establishment in some cases with a view to giving the heavy guns of the fortress this power of stopping blocking vessels at night.

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THE MECHANICAL CONVEYANCE OF ORDERS.

By Major L. J. Dopping-Hepenstal, R.E.

Of late years, on shore, orders and instructions seem seldom to be conveyed by purely mechanical means, electricity and electrical dials being much used, often unaccompanied by any other alternative means of communication. Mechanical telegraphs still hold their own in the Navy and merchant shipping, and it is worth considering whether, for short distances, in and around forts, etc., we make sufficient use of purely mechanical means. There would appear to be a field of usefulness for mechanical telegraphs in forts. I often thought, also, that we neglect too much the old-fashioned speaking tubes as an auxiliary aid.

The commonest form of telegraph usually met with consists (roughly speaking) of two dials, so mechanically connected that when the pointer on the Bridge Dial is made to point to a certain instruction set forth thereon, the pointer on the Engine-room Dial takes up a position pointing to the same instruction (*e.g.* "Full Speed Astern"), a gong being at the same time rung; any motion in either direction rings the gong to call attention. It is supplemented by a reply arrangement, and sometimes also by an automatic compliance indicator, neither of which it is necessary to describe here. The working is done usually by an endless taut chain, the pointer in each dial being rigidly connected to a sprocket wheel (or pinned drum or disc), from which the chain takes its motion. As a matter of economy and simplicity, long straight stretches of chain are always replaced, between points of change of direction, by lengths of stout wire, this in no way affecting the theory or working.

In all such dial instruments we get :—

(1). An idea or intention of the Commander (*e.g.* "Full Speed Ahead"; "Commence Firing").

(2). A translation of this idea in his brain to an action, a particular movement of a handle to correspond with that particular idea or intention.

(3). At the other end, the reception of the idea through visually reading a written instruction conveyed by the pointer.

(4). A translation in the brain of this idea or intention of the Commander into a mechanical action with the hands, the selection of a particular direction and the movement of a particular lever to correspond to this idea.

This all takes time, and moreover the translations are not always correctly made in the brains concerned. Formerly the controlling

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handles on the Bridge usually moved in a horizontal plane (like those of an electric tram car). Instances of this are still to be seen. Mistakes were occasionally made, until it was found of great advantage to give the handles fore-and-aft motion, in vertical planes, so as to bear some obvious relationship to the intentions and orders they were meant to convey. A man on a bridge can make no mistake when, if he wants to go ahead, he pushes his handle to point ahead; if he wants to stop, he pulls it up to vertical; and if he wants to go astern, he pulls it back to point astern. This was found to be so practical an improvement that almost all the newer transmitters are now so made, in spite of being a little more troublesome to manufacture and fit. It is an extraordinary thing that the controlling handles of electric trams are seldom or never so arranged. Many a tram accident would be prevented if the handle were pushed forward to go ahead and pulled back to stop or go astern; the driver would then be likely to stop the car automatically or unconsciously if he lost his head. In the new ship *Minnesota*, which has attracted much attention, all the electric hoists have the same defect; many an awkward hitch would be saved if the handles moved in a vertical plane, *up*, to hoist, *down*, to lower.

In 1890 this principle (which one might paraphrase as "the object all sublime of making the punishment suit the crime") was carried out in a device of mine that was used at Halifax, Nova Scotia, for some years to control the movements of an electric search light.

The Commander's end consisted of a small arm moving round in a vertical plane, with a small knob (or horizontal handle) at its outer end for convenience. When the knob was moved to the right, the order "Move to the Right" was conveyed; when it was moved to the top (arm being vertical), "Elevate"; when to the bottom, "Depress." When the handle was nowhere in particular—*i.e.* the arm not pointing obviously in either of the four directions (up, down, right, left), but inclined at somewhere about 45° to the vertical or horizontal—the order "Stop" was conveyed. This latter position is analogous to the negative predicament certain troops of the brave old Duke of York are said to have been in, when they were neither up nor down the hill—when they were *up*, they were *up*, and when they were down, they were *down*, etc. The man who could not convey what he wanted with this handle could be safely classed as a man without any ideas to convey.

At the Receiving end (the search light end) I had a little model 3-storied cottage of wood, about 4 feet high, 2 feet wide, and 6 inches deep (back to front), with an attic window, a ground floor or kitchen window, and two first floor windows; of the latter, the right (or starboard) window had a green (fairly transparent) blind, while the left window had a red blind. In the cottage was a single-stroke, low resistance, double-dome bell, which gave a whack every time the

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current was either made or broken. In each window was an ordinary electric light, and a five-cored cable connected the cottage with the Commander's post. The instructions to the manipulator of the search light were:—Light in Attic window means "Elevate" (keep elevating as long as the light shines); Light in Kitchen window means "Depress"; Light in Right (or green) window, "Move to Right"; Light in Left (or red) window, "Move to Left."

On one occasion, by turning the cottage seawards, the light on a torpedo vessel, moored near shore, was successfully directed by the Commander at the controlling station. It will be noticed that the relative positions of the lights here brought in a relationship between the act to be performed and the method of conveying the order; and that what I had done was merely to modify the Cardew light-box (one of Major Cardew's many ingenious inventions) to suit my cardinal theory.

In the case of a telegraph to a gun in a fort, I would have the indicator take the form of a diminutive representation of a gun, pointing horizontally towards the front for "Commence Fire," and thrown up vertically for "Cease Fire." The diminutive gun moved upwards through an angle of (say) 40°—45° might indicate "elevate more," and moved downwards the same amount "Depress," as the case might be, if such were desired.

To further exemplify the idea, I may describe the Engine-room Telegraph known by my name, published in 1894, and which can be seen at work in an occasional ship. It is said to still hold the field as the simplest telegraph in use. The theory of it is the exhibition to the engineer of the action required in miniature, instead of calling upon his brain to read a written instruction and translate it into action.

Mistakes in the engine room have been surprisingly frequent. Years ago I witnessed the strange accident to the fine Allan Liner *Sarmatian* in the dock basin at Liverpool, where she stove in her bow, and sustained such severe damage that the whole of her passengers and cargo, just embarked, had to be transhipped to another vessel; this was caused by the engines being put "Ahead" instead of "Astern," through brain-mistranslation. The *Lansdowne*, from the same cause, did over £200 worth of damage in a few minutes. The *Serapis* is said to have done an immense amount of mischief through the same mistake. History is full of similar records, in almost all of which the signal appears to have been correctly given from the Bridge and correctly returned by the hand reply (where such was used). All observant Submarine Mining officers will have come across instances, in the twin screw boats, where the engines were discovered to be going the wrong way, breaking and losing hook-ropes, and accompanied by a strained relationship between the coxswain and engine staff, and sometimes an exchange of amiable language.

My transmitter on the Bridge consists only of the usual fore-and-aft

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handle, moving through about 95° forward, and the same amount abaft the vertical. There is no dial, dials, to my mind, being of no practical value. Nor is there any hand reply, as in my device the handle itself can be used as a hand reply. The order "Stand By" is not indicated, as in other systems, by any definite position of the handle—which is very anomalous—; but is given by ringing the bell, by working the handle to and fro, and bringing the handle back to its correct position—*i.e.* to "Full Speed Ahead," if the engines are intended at the moment to be going full speed ahead. The order "All Clear" or "Alongside" is usually given by ringing 3 times as above, with a good pause between each ring.

In the Engine Room the gong is retained; but there is no dial, as the movements of a dial would bear no obvious relation to the actions of the engineer and would entail brain action to read and translate. My indicator consists of a miniature lever or wheel (according as a lever or wheel is used in engine), bolted in some convenient place before the eyes of the engineer, and so situated and fixed that its movements are relatively similar to those of the actual handle or wheel by which the engine is controlled; *e.g.* if the gong rings and the little handle moves up, the engineer moves the big handle up, etc. There is therefore much less chance of the ship being wrecked by a worn-out, stupid, alcoholically-saturated, or wool-gathering engineer whose thoughts are far away. The engineer responsible for the accident to the *Sarmatian* was said to be a man of very long service, much trusted and valued by his employers, and who had never had a hitch before; he would probably not have had *that* hitch if my model indicator had been used, however far away his thoughts were.

In cases where the engines are controlled by a wheel, the indicator consists of a miniature wheel, rotating through 180°, with a conspicuous red, white, or polished spoke to indicate the central or "Stop" position (normally vertical). Thus, if the wheel is seen to rotate through 90°, as shown by the bright spoke turning to horizontal, the large wheel is to be turned in the same direction as many turns, or as far as will make "Full Speed"; 45° would indicate "Half Speed." This is very similar to my steering telegraph from the bridge to the emergency wheel astern, the transmitter on bridge, as well as the dial astern, being replaced by diminutive model steering wheels.

My automatic engine-reply consists of a small spur wheel, revolving on the bridge at a maximum speed of 30 revolutions a minute (with engines at full speed), and capable of being both seen and felt. It is unnecessary to further describe it here; I do not think it is much used.

The theory of the above described devices can be applied to the conveyance visually of certain military orders and information: *e.g.*, at the attack of a seaport, instead of a flag indicating "Commence

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Firing," a representation of a gun like a semaphore may be used. This is unlikely to be misunderstood; seeing the muzzle thrown vertically up or down obviously implies "Cease Firing"; whereas a flag displayed in manœuvres often means "Commence Firing," whilst on a range it means "Cease Firing."

Some years ago realistic manœuvres took place at Halifax, Nova Scotia, which included a naval attack on the port. It was necessary to distinguish friendly ships from foes, and for this purpose the examining steamers used Verry's Pistols. It was agreed that 2 discharged rockets meant a *Friend* and 3 an *Enemy*. A hostile ship passed in, and the examination steamer tried to signal her; but the pistol jambed after the second shot, thus clearly indicating her to be a *Friend*, and she passed in unmolested. I would suggest that a wavy line, representing a serpent, should be displayed to indicate *Enemy* (a flag or a board by day, and wavy line of lights at night).

For "Commence Firing" I would suggest a row of lights hung horizontally on a board, shaped to represent a gun, and pivoted on a flagstaff; so as to be capable of being thrown vertical for "Cease Fire." Before the above-mentioned attack on Halifax, it had been agreed that hoisting a Red Lamp meant "Commence Firing." As the night wore on, the enemy's ships were discovered to be entering the harbour, and the lamp was ordered to be hoisted; but an accident happened and the glass broke, the lamp being blown out; and the enemy sailed in past the forts without being fired at. It was impossible, in the time available, to improvise any substitute for the missing lamp. There was telephonic communication; but by the time the messages got through, it was too late. Both of these failures were due to the neglect of very ancient axioms, founded on the prudent method of a vendor of eggs, who carries them in several baskets, so that if one basket comes to grief he will not be wholly undone; and of the sagacious archer who carries a second piece of string with him.

Voice Tubes are hardly mechanical means of conveying orders; still, we will include them. It seems to me that we do not use them often enough. I have never seen a sentry box or post (Barrack or Fortress) connected to its guard room by a voice tube; but I have seen a great number of places in which one would be very useful, as the sentry could get instructions or report odd things that occurred.

I have seldom seen a Mechanical Bell between a sentry's post and the guard room. I *have* seen a few instances; but in all of these the bell was rung by a handle, as have been all electric sentries' bells that I have seen. It is as easy to ring them by a treadle as by a handle; and it is possible to conceive occasions on which a sentry would prefer not to sacrifice momentarily the use of one of his hands in order to ring a bell, as such sacrifice might entail the loss of his rifle. Anyhow make the suggestion that sentries' bells should be rung by foot.

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*THE ENGINEERS OF THE GERMAN ARMY.**

By Col. J. A. Ferrier, d.s.o., R.E.

II. COMMUNICATION TROOPS (VERKEHRSTRUPPEN).

Organization.

A. 1 Brigade, consisting of a Traffic Section and 3 Railway Regiments, each of 2 battalions (Prussian).
   1 Railway Battalion (Bavarian).
B. 3 Telegraph Battalions (Prussian).
   1 Telegraph Company (Bavarian).
C. 1 Balloon Battalion of 2 companies (Prussian) at Berlin.
   1 Balloon Detachment (Bavarian) at Münich.
D. Experimental Detachment of Communication Troops at Berlin.

In Prussia the above are under an Inspector of Communication Troops, ranking as Major-General; but in Bavaria they are under the Inspector-General of Engineer Corps and Fortresses.

II. (A). RAILWAY TROOPS.

Railway Brigade (Prussian).

The Traffic Section is composed of a staff and 3 companies.

Each of the 3 regiments has 2 battalions of 4 companies each, numbered from 1 to 8.

The 7th and 8th Companies in the 2nd Regiment and a small portion of the Traffic Section are furnished by Saxony.

The Bavarian Battalion is composed of a staff and 3 companies.

The peace strength of units is as follows:— Peace Strength.

Unit.	Officers.	Medical Officers and Officials.	N.C.O.s and Men, exclusive of regimental tradesmen.	Horses.
Company (Prussia)	5	—	151	1
Company (Bav.)	5	—	156	1
Battalion (Prussia)	22	4	605	7
Battalion (Bav.)	17	3	469	6
Traffic Section	12	2	444	—

The total peace strength, allowing for regimental staffs, etc., is 177 officers, 15 medical officers, 18 officials, 712 non-commissioned officers, and 3,681 men.

No information is available as to distribution. Part of the force is employed on the Military Railway between Berlin and the Kummersdorf-Jüterbog ranges. The Bavarian Battalion is at Münich.

* *Continued from previous number.*

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War Formations.

On mobilization the 7 Railway Battalions and the Traffic Section are broken up, and the companies are expanded into

(*a*). Railway Construction Companies (Eisenbahnbau-Compagnieen).

(*b*). Railway Traffic Companies (Eisenbahnbetriebs-Compagnieen).

(*c*). Railway Workman Companies (Eisenbahnarbeits-Compagnieen).

The war strength is as follows :—

Units.	Officers.	Medical Officers and Officials.	N.C.O.s and Men.	Horses.	Vehicles.
Construction Co.	9	2	222	29	3 4-horse carriages. 2 2-horse do.
Traffic Co.	6	—	206	2	
Workman Co.	2	—	202	—	

The Construction Companies absorb the greater part of the men of the peace establishment of railway troops.

The Traffic Companies are mostly formed of Reserve officers and men, with a few officers, N.C.O.'s, and men of the peace establishment.

The Workman Companies are formed principally of Reserve men.

The *Armament* is the same as that of the Pioneers.

Personal Equipment.—No details available.

Transport.—Two 4-horse wagons for tools and appliances; one 4-horse wagon with ladder sides for stores; one 2-horse baggage wagon; and one 2-horse carriage for telegraph purposes.

TRAINING.

The military training is the same as for Pioneers, *i.e.*, drill, gymnastics, rifle exercises, and musketry.

The technical training comprises the demolition and repair of railways and bridges of all kinds; the construction of narrow gauge railways; and the traffic management of ordinary and field railways.

The training takes place near Berlin. But companies are very often detached to construct, re-construct, and repair State and Private Railways, particularly if an accident has occurred and a provisional line is required; while thus employed the rank and file receive working pay, varying from 3¾d. to 8¾d. a day.

Railway management, generally, is learned on the military railway between Berlin and the Kummersdorf-Jüterbog ranges. This line is managed by the military though, like other railways, subordinated to the Ministry of Public Works.

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The Technical Troops of the German Army are exercised periodically in works of large scope, similar to what would fall to their lot in war :—*e.g.*, 1898, bridges only ; 1899, a few kilomètres of normal gauge line with a wooden bridge over the Oder ; and 1901, a field railway of 100 kilomètres. In 1904 a metal bridge was thrown across the Elbe at the end of a field line of 50 kilomètres which served to transport the materials for the bridge. Manœuvres.

Such exercises involve an expenditure of from £2,000 to £2,400, and as they therefore cannot be repeated yearly they are worthy of arresting our notice.

The Railway and Siege Manœuvres of 1896 have already been mentioned, but to give an idea of the scope of the Railway Troops I cannot do better than copy a few extracts from the account of the exercise of 1904 (*Revue Militaire des Armées Étrangères*, March, 1905).

"*Hypothesis.*—Wittenberg and Torgau are supposed to be besieged, and to restore communication by rail between the right bank of the Elbe and Leipzig it is necessary to construct a line connecting the Berlin-Jüterbog line with Eilenburg.

"Peace conditions determined the bridge site between Prettin and Domnitzsch, and the Civil authorities prescribed that navigation was not to be interrupted. The Elbe at this point, measured at flood level, between embankments, is about 1 km. wide ; but owing to the dryness of the summer the waterway was reduced to 60 m., with a maximum depth of nearly 2 m.

"A clear span of 60 m. being obligatory it was decided to utilize the Lübbecke steel girder bridge material, part of which was stored at Berlin and part on the training grounds of Clausdorf and Sperenberg not far from the Berlin-Jüterbog line. Of course this could have been brought by rail to Annaburg. But the supposition was held to be that railway communication beyond Jüterbog was closed ; and so a line of about 50 km. from Jüterbog to Prettin was decided on, and this was to be used to bring the material to bridge site.

"*Personnel.*—In the Prussian Brigade, including the 2 Saxon Companies, there are roundly 150 officers and 3,500 R. and F. The Bavarian Battalion has 3 companies, 17 officers and 450 R. and F. The Working Section on the military line Berlin-Jüterbog has 15 officers, 550 R. and F. Out of these were employed :—7 Prussian companies, 2 Saxon, and 1 Bavarian, and the Working Section of the military line ; there were also attached for 10 days 4 Prussian Reserve Companies. These 14 companies were brought up to war strength, each having 9 officers, 20 N.C.Os., 200 men ; total 150 officers (including staff) and 3,500 R. and F.

"The railway material of the German Empire has been provided for by a vote of £340,000, made up in annual contributions of £24,000 to £28,000 ; and no departure from original patterns has been found necessary.

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"The Lübbecke system of bridges merits some description. This was adopted in 1902 after £40,000 had been spent in experiments. Eight sections of bridge, each of 60 m. span, are estimated to cost £240,000; each section costs about £29,000. Parliament has voted approximately this sum annually since 1902.

"The bridge is made in separate pieces, each capable of being handled although some parts are actually 8 m. long. The bridge platform is carried on two lattice girders, 1·5 m. deep; it is wide enough for a double track, and is supported on the lower boom. As the span increases the extra depth of girder is obtained by piling on extra girders; in this case, for 60 m. clear span, 4 girders, equal to 6 m. in height, were required; the top girders were cross-braced to one another.

"The country traversed presents no serious engineering difficulties; it is a plateau with wide undulations as far as the Black Elster river, after that an open plain as far as the Elbe.

"Werder-Zinna, a few kilomètres north of Jüterbog was chosen as junction station for the field railway and the military line. The trace was as straight as the ground and certain private properties would permit: it passed by Rohrbeck, Oehna, Mügeln, Schweinitz, Annaburg, Naundorf to Prettin. The trace was indicated by the Director of the Exercise, the details and minimum radius of curvature being determined by the Tracing Section (Tracierkommando). Behind them came the Railway workmen to make up banks, dig cuttings, etc., for formation level, and bridge obstacles. The obstacles were:—

1. Jüterbog-Luckenwald light railway.
2. State line Jüterbog-Falkenberg, between Dennewitz and Rohrbeck.
3. Black Elster river at Schweinitz.
4. State line Wittenberg-Falkenberg, near Annaburg.

"The Black Elster was crossed by a pile bridge which took two days to construct; the railways by wooden viaducts at a gentle incline.

"Work began on 29th July at Werder-Zinna; on 8th August the rails reached Prettin on the near bank of the Elbe; on 10th August the whole section was opened for traffic, and in the evening the first trains with sections of the steel bridge were discharging at bridge site; the railway was completed on 15th.

"Meanwhile the viaduct of approach to the water span, consisting of 320 mètres length of wooden trestles, had been begun on 26th July, as also the abutments and erecting platforms. These involved the driving of 276 piles with ordinary pile drivers moved about by hand, the water being too shallow to admit of the use of floating pile drivers. The piles were in by 10th August. The 11th and 12th were devoted to completing the platforms; and the erection of the girders,

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commenced on 13th, was finished on 26th, on the afternoon of which date a heavy goods train was sent across. The line was not completed up to the main line as the exercise was considered concluded with the completion of the girder bridge.

"Under peace conditions the work took 4 weeks. It is considered that in war, when no regard would have been had to keeping the waterway open for mercantile traffic, the work could have been completed within 3 weeks."

II. (B). TELEGRAPH TROOPS.

Prussia.—In Prussia there are 3 battalions :—

1st Battalion, stationed at Berlin, belongs to the Guard Corps. The 3rd Company is Saxon, and there is a detachment of Württembergers. To this battalion is attached the Cavalry School of Telegraphy.

2nd Battalion, stationed at Frankfort on the Oder, belongs to III. Army Corps.

3rd Battalion, stationed at Coblenz, belongs to VIII. Army Corps.

Bavaria.—In Bavaria is a Telegraph Company,* to which is attached the Cavalry Telegraph School,† at Münich, and a Balloon Section.

Inspector of Telegraph Troops.

The Inspector of Telegraph Troops is directly under the Inspector of Communication Troops. He holds the rank of Regimental Commander. His control embraces all questions concerning Military Telegraphy and Pigeon Posts.‡ He is the immediate C.O. of Telegraph Battalions and directs their instruction, military and technical.

Strength.

The total effective strength of the combined Telegraph troops is 50 officers, 165 N.C.O.'s and 1,353 R. and F. under the Inspector of Telegraph Troops.

Officers.

The officers are drawn mostly from Engineer and Pioneer officers, some from Infantry and from the Railway troops. The Budget of 1902 provided 9 Commissions (8 Prussian, 1 Saxon) to go to men trained in Telegraph Units.

Transport.

There are no horses. Teams are provided by the Train, who hold, specially set apart for Telegraph troops, 3 groups of teams attached to Nos. 3 and 8 Battalions of the Train of the Guard. One group, also attached to the Guard, is detailed for the Cavalry School of Telegraphy.

* 2 Captains, 1 Senior Lieutenant, 3 Lieutenants, 1 Paymaster.

† 1 Captain of Engineers, 2 Senior Lieutenants of Infantry, 1 Lieutenant Foot Artillery.

‡ See also I. A. (i.) under "Engineers," who draw a certain number of pigeons from the Telegraphs for use in Fortresses.

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The strengths of the groups are as follows :—

	Telegraph.	Cavalry School of Telegraphy.
Lieutenant	1	—
Vice Wachtmeister	1	—
Sergeant	1	—
N.C.O.'s (1 Farrier)	3	—
Lance Ranks	3	1
Privates	31	11
Labourers	1	—
Horses { Saddle	9	25
Horses { Draught	39	—

Strength of Units.

The establishments of the Prussian Telegraph units are as follows :—

	Company.	Battalion of 3 Companies.
C.O.	—	1
Captains	1	4 (*a*).
Senior Lieutenants }	4	{ 3
Lieutenants }		{ 7 (*b*).
Paymaster	1	1
Doctor	—	2
Armourer	—	1
Feldwebel*	1	3
Vice Feldwebel	2	3
Fähnrich	—	3
Sergeants	5	13
N.C.O.'s	10	26
Drum-Major	—	1
Probationer Paymaster ...	—	1
Old Soldiers	2	6
Lance Ranks	13	33
Privates	135	357
Hospital Orderlies	1	3
Labourers	1	3
Totals	5 Officers. 1 Employé. 18 N.C.O.'s. 152 Men.	15 Officers. 2 Medical Officers. 2 Employés. 50 N.C.O.'s. 402 Men.

(*a*). 1 belongs to Battalion Staff.
(*b*). 1 Adjutant.

Armament and equipment are the same as for Pioneers.

Training and Instruction.

The military training is the same as for Pioneers. Individual instruction in gymnastics and foot drill has to be finished by the end of January.

* Feldwebel is about equivalent to Co.-Sergt.-Major or Colour-Sergeant.

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The technical training includes :—all details of military telegraphy (electric and optic) and telephony. It begins with handling apparatus, erecting lines, and share of work in autumn manœuvres. The details are arranged between I.G. Communication Troops and the Commanders of Army Corps.

The military *réseau* of Berlin, connecting all barracks and principal military buildings, is maintained and worked by the Corps under the direction of the senior officer, chief of the electro-technical section of the Engineer Committee.

The regulation and text-books are :— Regulations and Text Books.

1. *Telegraphen Bau Ordnung.* 1877.
2. *Vorschrift für die Handhabung des Dienstes auf Feld-telephon Stationen.*

II. (C). BALLOON TROOPS.

The Balloon Corps comprise :—

Prussian Battalion of 2 companies at Berlin.
Bavarian Section at Münich.

Total, 16 officers, 54 N.C.O.'s, 343 men.

The establishments are :— Strength.

	Prussian Battalion, 2 Companies.	Bavarian Section.
Field Officer, C.O.	1	—
Captains	5 (*a*)	1
Senior Lieuts. and Lieuts. ...	7 (*b*)	3
Medical Officers	1	—
Paymasters	1	1
Foremen	1	—
Armourer	1	—
Feldwebel	2	1
Vice Feldwebel	2	1
Sergeants	12	5
N.C.O.'s	21	7
Probationer Paymaster ...	1	—
Old Soldiers	4	2
Lance Ranks	28	10
Privates	227	68
Labourers	3	—
Hospital Orderlies	2	1
Totals ...	13 Officers. 1 Medical Officer. 3 Employés. 38 N.C.O.'s. 264 Men.	4 Officers. 1 Paymaster. 1 Employé. 14 N.C.O.'s. 81 Men.

(*a*). 3 Professors.
(*b*). 1 Adjutant.

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At Berlin 15 officers from other arms are received from 1st April for 3 months' instruction in captive and free ballooning. Many other officers are also instructed in captive work. The course at Berlin is independent of the exercises at the Fortresses, which are performed by officers and men of the garrison under the direction of officers of the Balloon Corps or of officers selected from those who have received instruction.

Equipment, etc. *Matériel.*

The *armament and equipment* are the same as for the Pioneers.

The *matériel* consists of :—

1. A spherical balloon, for free runs.
2. A sausage-shape balloon, called "Drachen (kite) Balloon," for captive work, especially when the velocity of the wind (beyond 10 mètres per second)* makes it difficult for spherical balloons.

Below the sausage balloon is fixed a long inflated rudder formed like a caterpillar. A small balloon inside the large one can be filled with air to make the system more rigid. The car is attached so as to tilt the prow of the balloon and give it a tendency to lift.

The objection to this form of balloon is that it is not suitable for free runs.

It is held in position by a cable of 5-m.m. still wire, 1,000 mètres long.

The gas is hydrogen, compressed to 150 atmospheres in cylinders. The latter are carried 12 to a 6-horse wagon. Six wagon loads are required to fill one balloon.

Company Transport.

The vehicles are :—

First Line.—2 wagons, rigging ; 12 wagons, gas ; 1 wagon, windlass—all 6-horse.

Regimental Column.—1 forage wagon, 4-horse ; 1 ration wagon, 2-horse ; 1 baggage wagon, 2-horse.

There are 124 horses, of which 22 are for saddle. But in peace time the following detachment is maintained by the Train and attached to the Balloon Corps :—

Lieutenant	... ...	1
Vice Wachtmeister	... ...	1
Sergeant... ...	... ...	1
N.C.O.'s (1 Farrier)	... ...	4
Trumpeter	... ...	1
Lance ranks	... ...	5
Privates ...	... ...	25
Labourers	... ...	1
Horses { Saddle	... ...	14
Horses { Draught	... ...	44

* 20 miles an hour.

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Balloonists.—5 officers (including Captain of Section), 12 N.C.O.'s, 95 balloonists. *Personnel.*

Auxiliaries: Train.—2 Officers, 1 Medical Officer, 1 Veterinary Officer, 7 N.C.O.'s, 54 Privates, 1 Hospital Assistant, 1 Shoeing Smith; total—7 Officers, 1 Medical Officer, 1 Employé, 170 R. & F.

Matériel and *personnel* are divided into 2 divisions, each with 6 gas wagons; 5 balloonists can be carried in each wagon. Company Organization.

Empty wagons are filled up with gas by special convoys called "Gas Columns," which exchange cylinders. One of these convoys marches with the 1st Ammunition Column, having enough gas for 2 fillings.

It is admitted (Regulation, 7. 10. 1901) that observation beyond 7 kilomètres is difficult. In favourable circumstances the balloon can ascend 1,000 mètres, but 600 is normal. In good weather the car holds 2 officers. The Regulation prescribes the employment of balloons in sieges, either for attack or defence, either captive or free. Capabilities.

Special, dated 8. 10. 1903, *Exerzier—Reglement für Luftschiffer.* Instructions and Regulations.

Instruction in drill, etc., is confined at first to what is absolutely necessary for the single man and to maintain discipline; and the principle is inculcated that "The balloonists only resort to arms to defend themselves, the balloon, or the wagons."

As soon as the recruits have made some progress the technical instruction is begun. But later on they are taught all the drill requisite for men to fight in close or extended order in bodies as large as the company.

The Regulation prescribes 7 groups or squads.

	N.C.O.'s.	Men.
Balloon Group	2	38
Gas ,, ...	1	12
Car ,, ...	1	4
Windlass ,, ...	1	4
Telephone ,, ...	1	4
Advance Guard Group	1	4
Reserve	1	10

The handbook appears to be a very complete and sensible publication, entering into few details. In its 138 pages, about 6″ × 4″, it compresses the individual instruction of the soldier, rifle exercise, company drill, close and extended order, balloon drill with both kinds of balloon, general instructions for the field and for sieges, equitation, driving, ceremonial.

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III. (A). GARNISON BAUWESEN.

The Barrack Construction Department is a branch of the Intendantur, an administration that manages the household matters of the army, *e.g.*, supply, barracks, and pay, and with which the Engineer Corps has no connection.

The officers of this branch are recruited from officers of the active army who have served at least 6 years; they go through a course lasting 2 years and 3 months, and pass an examination. The subordinate staff are obtained from N.C.O.'s of the army, who must have served 10 years and have passed a six months' course of instruction.

Duties. This Department, however, only prepares estimates. The construction and repair of barracks are carried out entirely by civil labour under civil supervision; the cost is frequently borne by the town or city concerned, which pays gladly for the privilege of maintaining a large money-spending garrison.

The system has the merit of providing, in peace time, employment for Reserve Officers who become available in war.

Personnel. The *personnel** is as follows: —

Prussia.

33 Intendantur and Bauräte (Control Department and Members of the Board of Works).
145 Garnisons Bauinspektoren (Garrison Building Inspectors).
18 Intendantur Bausekretäre (Control Clerks of Works).
106 Garnisons Bauwarte (Garrison Foremen of Works).
106 Garnisons Bauschreiber (Garrison Clerks of Works).

Saxony.

4 Intendantur and Bauräte.
15 Garnisons Bauinspektoren.
2 Intendantur Bausekretäre.
11 Garnisons Bauwarte.
11 „ Bauschreiber.

Würtemberg.

2 Intendantur and Bauräte.
8 Garnisons Bauinspektoren.
1 Intendantur Bausekretär.
6 Garnisons Bauwarte.
6 „ Bauschreiber.

* From Army Estimates, 1905, and Bavarian Army List.

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Bavaria.

2	Garnison	Verwaltung	Direktor (Director).
10	„	„	Ober Inspektoren (Chief Inspector).
8	„	„	Kontrolleur (Controller).
21	„	„	Inspektoren (Inspector).
45	„	Kasernen	Inspektoren (Barrack Inspector).

III. (C). SURVEY DEPARTMENT.

Officers.

The Survey Department is under the Chief of the Great General Staff; and is managed now, though not necessarily always, by one of the 4 Quartermaster-Generals (a Major-General or Lieutenant-General) as "Chief of the Survey."

The Chief of the Survey—at present the 4th of the Quartermaster-Generals—has an Adjutant, and is assisted by the following officers of the Great General Staff:—

1	Major-General.
1	Colonel.
2	Majors.
13	Captains.
Total 17	

In addition to these there are 6 officers (Captains and Lieutenants) attached to the Trigonometrical Section, 25 (Lieutenants) to the Topographical Section, and 10 (Majors, Captains, and Lieutenants) to the Cartographical Section.

Officers.

The Officer topographers are selected from those officers who show most aptitude for topographical work during their course at the Staff College (Kriegsakademie). In the 2nd year of their course students at the Staff College do 4 hours' topography a week, and in the 3rd year they have in addition a 3 weeks' "practical" course. Those who distinguish themselves are put into a so-called "T" class, and undergo a 14 days' practical and literary examination. According to the result of this examination officers are selected for attachment to the Great General Staff for a period of 1 to 3 years.

The higher ranks are selected from those who have been "Topographers," and also from other officers throughout the service according to their capacity and the requirements.

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Civilian *Personnel.*

The civilian *personnel* consists of the following :—

1	Map room inspector.
8	Directors of survey.
125	Surveyors and draughtsmen.
31	Assistant do. do.
3	Technical inspectors.
1	Superintendent of printing.
1	Chief photographer.
32	Engravers, lithographers, and photographers.
13	Assistant do. do.
15	Printers and galvanizers.
14	Assistant do.
20	Clerks and secretaries.
4	Assistant do.
7	Technical assistants.
17	Messengers, porters, etc.
Total 292	

Topographical

A proportion of the above "civilian" surveyors and draughtsmen, in the Topographical Section only, are Non-Commissioned Officers of all arms, who have been trained as follows :—

They first undergo a course of one year's duration at the Pyrotechnic School (Oberfeuerwerkschule), during which they are trained in drawing and in the elements of theodolite and plane-table work. Those who show most proficiency are sent to the Topographical Section of the Great General Staff, where they are trained for another 3 years or more as draughtsmen, surveyors, etc.; the remainder are sent back to duty.

The selected men, if satisfactory, then leave the army and are engaged as Civil Officials (Zivilbeamte). After 10 years they get paid at the rate of £105 a year with £27 a year lodging allowance, rising at 3 years intervals to £130, £155, £180, £205, and £220.

The genuine "civilian" printers, draughtsmen, clerks, etc., are engaged and paid as required; there is no Government training school of any sort for them.

Cartographical

As regards the Cartographical Section :—The men must, as a rule, have passed the examination qualifying them for service as "One-year Volunteers," but need not have done their service. Practically all of them are brought in from outside, efficient artisans being enrolled irrespective of where they may have received their training.

The Chief of the Section is very anxious to have a Government School for training them, but at present there is no such institution. As it is, the wing of the Great General Staff allotted to the Survey Department, although large, does not nearly provide the full accommodation required.

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Distribution of Work.

The Department is divided into :—

(1). Trigonometrical Section.
(2). Topographical Section.
(3). Cartographical Section, for printing and reproduction, and Map Room.

Trigonometrical Section.

The Trigonometrical Section has to cover the whole country with a network of triangulation, 10 stations in stonework being erected per German square mile (1 German mile=7½ kilomètres=4·68 English square miles) in addition to other suitable objects which are fixed. The heights of these points are also determined.

Topographical Section.

The Topographical Section carries on the topographical survey, and makes the original plane-table drawings.

Cartographical Section.

The Cartographical Section, in addition to printing and reproducing all Ordnance Survey and Military maps, carries out all printing and drawing for the General Staff and undertakes the distribution of maps.

Trigonometrical Section *Personnel.*

The *personnel* of the Trigonometrical Section is as follows :—

1 Chief of a Section 6 Directors	} Officers of the General Staff.
1 Director (employé).	
8 Attached Officers (Captains and Lieutenants).	
26 Surveyors and Assistant Surveyors.	
4 Clerks.	
1 Messenger.	
Total 47	

This Section is divided into 5 sub-sections with various duties.

Topographical Section *Personnel.*

The Topographical Section comprises :—

1 Chief of a Section (Major) 6 Directors of Survey (Majors or Captains)	} Officers of the General Staff.
25 Attached Officers (Lieutenants) as Topographers.	
79 Surveyors and Assistant Surveyors.	
3 Survey directors (Beamte), inferior class.	
3 Registrars ,,	
Total 117	

Organisation.

This Section is sub-divided as follows :—

Registry (Office of the Chief of the Section).

Sub-sections { A. B. C. D. E. F. } for the Topographical Survey (1 director, 5 attached officers, and 10 to 12 officials).

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Sub-section G. for the custody of instruments and for directing the survey (1 director and 3 senior officials).

„ H. for detailing trigonometrical points. 1 official in charge. The work is carried out by officials during the winter.

„ I. for preparing reductions of the district surveys. 1 official in charge, with one or two officials as assistants. The work is carried out during the winter by officials and by specially engaged young ladies, who are paid 2—3 marks a day and can be discharged at any time.

Enquiry Sub-section for correcting existing maps. This is immediately under the Chief of the Section. The work is carried out by several senior officials.

Cartographical Section *Personnel.*

The Cartographical Section has :—

1 Chief of a Section
2 Directors
} Officers permanently attached, but not actually belonging, to the Great General Staff.

2 Directors (employés).
10 Attached Officers (Majors, Captains and Lieutenants).
5 Technical Inspectors, including 1 Superintendent of Printing and 1 Chief Photographer.
53 Draughtsmen and Assistants (Cartographers).
42 Lithographers and Engravers on copper.
1 Photographer.
1 Chief Printer.
1 Galvano Plastic Modeller.
1 Assistant do. do.
13 Printers.
1 "Glass" printer.
7 Technical Assistants.
10 Attached do.
2 Copper printers.
1 Coloured work printer.
1 Diätar (assistant not permanently attached).
6 Registrars.
2 Secretaries.
1 Servant.

Total 163

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This Section is divided into the following sub-sections :— Organisation.

1. The 1:100,000 Map, "Reichskarte" (plain), under a permanent officer.
2. The 1:25,000 Plane-table work.
3. Galvano-plastic (relief) and Photographic work. } under a permanent officer.
4. Printing. }
5. War Maps (China, S.W. Africa, etc., and maps for European Wars).
6. The 1:200,000 Map (plain).
7. The 1:200,000 Map (coloured).
8. The 1:100,000 Map (coloured).
9. Fortress Plans (this sub-section is attached to, and works under, the Chief of the General Staff).

Geodetic work is performed by the Geodetic Institute under the direction of the Ministry for Spiritual, Educational, and Medical Affairs. Geodetic Work.

Geological Surveys are carried out by the Royal Geological Land Institute, under the direction of the Ministry of Commerce, Industry, and Public Works. Geological Survey.

The Survey Department, or rather the Chief of the Great General Staff, is in close touch with both the above Institutes, and arranges the yearly task in conjunction with them, but there is sometimes friction.

There are no special "Forest" surveys. Forest Survey.

The Map Room is under the Cartographical Section, the Map-Room Inspector being nevertheless responsible for the proper working of his department. Map Room.

The issue of maps, both to the Army and to the Public, is effected by the Map Room, except in so far as it is handed over to Messrs. Eisenschmidt (the Edward Stanford of Germany). On the other hand the issue of manœuvre maps (except for the Kaiser manœuvres) and of maps of the environs of military stations, required for military purposes, is effected by the Cartographical Section. Issue of Maps in Peace.

For issue of War maps see below.

As stated above, the Survey Department is directly under the Chief of the General Staff. The Chief of the Survey is a member of the Central Direction of Surveys of Prussian Territory. According to the decisions passed by this body and the military requirements of the time, he receives from the Chief of the General Staff the general directions to be followed, both as regards technical assistance and the execution of the proposed work. Administration of Survey.

At the beginning of each working year the Chief of the General Staff gives out a so-called "Pensum," or task, of about 200 square miles (German), *i.e.*, about 4,380 square miles (English), of German Territory, to be surveyed on a scale of 1 : 25,000. Yearly Task.

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A survey on this scale, dating prior to 1873, already exists, but it is of course a good deal out of date. It was not very accurate originally, and the conventional signs are not those now in use; furthermore it was not published at the time it was prepared.

The present "task" consists, therefore, in checking it, bringing it up to date, and drawing, reproducing, and issuing an edition thereof; also of preparing a survey from it on a scale of 1 : 100,000. The old 1 : 100,000 map, before 1873, was published, but it was bad; Germans pride themselves on the accuracy of the new map.

Execution of Topographical Work.

The work is plane-tabled during the spring, summer, and autumn by the Topographical Section staff, who of course have the trigonometrical points to base their work on, and the old maps to go by to a certain extent. Although the "task" sounds formidable in quantity, it works out to rather less than one English square mile per day per 1 officer and 3 assistants.

Besides this survey, special maps or plans may have to be prepared by the Topographical staff.

Execution of Cartographical Work.

During the winter the work is carefully drawn and coloured by the Section. It is then photographed and coloured, and the result handed to the Cartographical Section. The latter Section, beginning in April, engraves or lithographs the plates, prints the maps (both plain and coloured), and distributes them in bulk when necessary.

The *process of reproduction* is as follows:—

On receipt of the original drawing and photographed copies from the Topographical Section, the Cartographical Section photographs the 1 : 25,000 maps on to stone (or, in the case of the 1 : 100,000 maps, transfers them on to copper), and engraves them on stone (or copper). They would prefer to do the whole on copper, but cannot get the necessary workmen in sufficient numbers. Saxony, Baden, and Würtemberg do the whole of theirs on copper; but Bavaria, like Prussia, does the 1 : 25,000 on stone.

Three-quarters of the maps are printed under contract by firms outside the office, although over 10,000 stones are in the office. Copper engravers are also employed outside the office.

The *scales* ordinarily employed are as stated above, 1 : 25,000 and 1 : 100,000.

A coloured edition (blue and black only) of the 1 : 100,000 map is being issued; but as yet only about 50 sheets, of Western Germany, have been completed. A 1 : 25,000 map is also to be had, coloured by hand in blue only. There is also an edition, coloured (in black, brown, blue, and green) or uncoloured, on the scale of 1 : 200,000. A few maps on the scale of 1 : 300,000 (coloured in red, black and blue) have been issued at a cheap rate, 20 pfennig per sheet, for sale to soldiers, etc.; they are excellent, and 37,000 of them were sold in 1904.

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Supply of Maps on Mobilisation.

There is a branch—sub-section 5—of the Cartographical Section, called "Die Verwaltung der Kriegs-Karten" (Administration of War Maps), part of whose business it is to keep the troops supplied with up-to-date maps for war purposes.

The maps are decentralized and kept at the headquarters, or even quarters, of the unit concerned.

Field Survey Parties.

The first attempt at organized Field Survey parties is now being made in S.W. Africa, a "Feldvermessungs" party (consisting of 1 captain, 3 officers for trigonometrical and 6 for topographical work, 1 assistant triangulator, 2 photographers, and 2 printers) having been sent there.

It is in the nature of an experiment, and the authorities are looking forward with much interest to the result, as it may lead to permanent parties being organized.

Map Reproduction in the Field.

The method of reproduction in the field is photo-lithography, reproduced on zinc plates, not stone. Aluminium plates, although they would be better and lighter for field work, cannot be used, as there is difficulty in supplying the acids for this work.

During manœuvres the Cartographical Section provides, at the Headquarters of the Manœuvres, a small sub-section for drawing and reproducing manœuvre maps by "transfers" on stone or aluminium.

Cost of Survey.

The annual cost of the Survey is about 1,250,000 marks (£62,500).

Survey of Colonies.

Outside Germany, Kiao Chau is the only Colony where the survey is done by the military authorities. In all other Colonies it is carried out principally by civilians under the control of the Colonial Section of the Foreign Office.

Correction.

On page 34 of the previous number, the second sentence of the first para. under the heading I. A. (ii.) should read:—"It is subject to the Inspections of the Corps of Engineers."

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APPENDIX.

UNIFORM.

CORPS OF ENGINEERS.

Tunic, dark blue with black velvet collars and cuffs, the former slashed with two silver bands, and silver epaulettes; except Saxons, who wear dark green tunics with scarlet collar and cuffs. Silver buttons.

Trousers, dark grey with scarlet piping. *Pantaloons* (apparently) dark blue without any piping.

Boots, butcher, accordion pleated at the ankle, with heel spurs.

Head-dress, helmet with silver badges and white horsehair plume.

Sword, straight with steel scabbard.

Great Coat.—Grey, with red shoulder straps and 1 silver slash on collar.

CORPS OF FORTRESS CONSTRUCTORS.

The uniform is similar to that of Engineer and Pioneer officers, with some differences of detail, *e.g.*—

They wear epaulettes instead of shoulder straps (except the Wallmeister who wear shoulder straps, black for Prussia and Würtemberg, green for Saxony). The letters F.B.O. are worn on the epaulettes and shoulder straps instead of numbers.

The *great coat* is blue cloth, with red piping and black velvet collar.

Trousers.—Infantry pattern.

Head-dress.—Helmet, as for Engineer officers, but without plume for Saxony.

Cap, as for Engineer officers, with black velvet brow band and red piping.

The Fortress Warders have much the same uniform, but the epaulettes carry a stamped silver wreath with gold coat of arms enclosed.

For further details see *Das Festungs Bau Personal* by H. Herde, F. Oberleut., to be obtained from R. Grundmann, Glogau, from which publication these notes have been extracted.

PIONEERS.

Tunic, dark blue with black collars and cuffs piped with scarlet, scarlet shoulder straps with battalion number. Saxons wear dark green instead of dark blue. White buttons.

Trousers, dark grey (Bavarians, dark blue) with scarlet piping.

Pantaloons, dark blue without piping.

Head-dress, black leather helmet with white ornaments and spike.

Great coat, dark grey.

Boots, butcher, for mounted men; short Wellington for dismounted.

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The Guard Pioneer Battalion is distinguished by:—

Head-dress, black plume instead of spike.

Tunic, two silver slashes on collar and cuffs.

Great coat, one silver slash on collar.

No number or device on the red shoulder strap of tunic or great coat.

RAILWAY TROOPS.

The uniform is almost the same as Pioneers'. On the collar are tabs of black and white horizontal stripes; on the cuffs, depending from the 2 buttons, two straps of black and white; E in yellow on the shoulder straps, with winged wheel for Traffic Section.

Head-dress.—Black leather helmet, with white plate and yellow chain and black dragoons' plume.

The Bavarian tunic is of lighter blue than the Prussian. The Bavarians wear a spike instead of plume.

TELEGRAPH TROOPS.

For 1st Battalion the same as the Guard Pioneers; for 2nd and 3rd that of the Line Pioneers. On the red shoulder straps there is a yellow thunderbolt and the battalion number in Roman character. These ornaments for the officers are gilded.

BALLOON TROOPS.

The uniform is the same as for the Pioneers. But the letter L is carried on the epaulettes and shoulder straps; and a shako is worn instead of a helmet.

TRAIN.

Tunic, dark blue with light blue collar, cuffs, and shoulder straps. Saxons, light blue, with black collar and cuffs piped scarlet, and light blue shoulder straps.

Trousers, black; Saxons with thin scarlet stripe.

Pantaloons, dark blue strapped with leather.

Boots, mounted men, butcher with heel spurs; dismounted, half Wellington.

Head-dress, black shako with back and front drooping peaks, falling black plume, yellow ornaments. Saxons, black shako cut straight below, cheese-cutter peak; light blue *pom-pom*, white side ornament, and yellow plate.

Great coat, dark grey, with light blue collar tabs and shoulder straps (12th and 19th—black collar tabs).

The Guard are distinguished by the slashes on collars and cuffs as for the Guard Pioneers.

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TRANSCRIPTS.

HUTTED HOSPITALS IN WAR.

As R.E. Officers may at any time find themselves called upon to design and erect huts for hospitals on Lines of Communication, it may be useful to record in these columns the experience gained during the late war in South Africa.

The following notes on constructional details are extracted from the official *Report on the Medical Arrangements in the South African War*, by Surgeon-General Sir Wm. D. Wilson, K.C.B., Principal Medical Officer, South African Field Force.

The portions marked as quotations are extracts, included in the above publication, from the Report of a Committee of Medical Officers which was assembled in South Africa.

The notes in brackets after certain paragraphs are presumably comments by the Principal Medical Officer.

The original is fully illustrated with plans; but these are not reproduced here as, with the exception of the "General Scheme for Hospital Camp," the letterpress is sufficiently clear by itself.

General Remarks.

Where a hospital is likely to be more or less permanent, as in the case of those at the base and at certain fixed points on the Line of Communication, it is an undoubted advantage to replace the tents by huts, and to add more satisfactory accommodation for stores and other necessities than can be provided under canvas. The following pages, therefore, include a description of the type of huts for ward use, and of the various accessories which were found useful in the late war. All the buildings described were in use in one or other of the general hospitals during the campaign, though all may not have existed in one hospital.

It is, of course, not proposed that all these buildings should be invariably provided. As the Committee points out, this is largely dependent on the probable time during which the hospital will be in use, and probably in some cases existing buildings will be available for conversion to hospital purposes. But where suitable buildings do not exist, it certainly adds to the efficiency of the unit and to ease in its working when buildings are provided. The following pages should, therefore, be taken as describing the ideal to which the development of the hospital should tend, and not as a statement of the necessities from the outset.

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These semi-permanent structures may be divided into the following classes:—

(1) *Those which are necessary from the very first*—
  (*a*) Latrines; disinfecting apparatus.
  (*b*) Lavatories; surface drains.
  (*c*) Water supply.
  (*d*) Kitchens; sculleries; milk stores; and the like.
  (*e*) Operating room.

(2) *Those which should be provided as soon as possible*—
  Storage accommodation for steward's store; pack, linen, clothing, and quartermaster's stores.

(3) *Those which are desirable, but not urgent*—
  Offices.
  Dining or mess-rooms; canteen; and the like.

(4) *Those which depend on local considerations*—
  Huts for use as wards.

Tents, especially the E.P. tent, do very well under most conditions, and the erection of huts is in most cases not a necessity for wards.

The Committee state—

"We are of opinion that huts should be used in General and Stationary Hospitals at the base for wards and other hospital accommodation; also, when practicable, at the advanced base or other positions where the lines of communication are secure, especially if there is prospect of a prolonged campaign, as we consider them more serviceable than tents, the life of which can only be calculated at six months. They should be constructed of wood and galvanised iron, with wooden lining to walls and roof and wooden floors, the boards being well laid with grooved and tongued junctions, the under surface of which should be tarred or creosoted with free air spaces underneath. The ground beneath should be concreted if possible.

"In all other positions and circumstances than those described above, we consider that tents should form the ordnance equipment of General Hospitals.

"As a similarity in size and simplicity of shape tends to expedite and facilitate erection we recommend that most, or as many as possible, be of same design and construction as per plans attached. In malarious and tropical climates they should be raised off the ground on masonry pillars 3 feet high. The ward huts should be warmed in cold weather by some form of ventilating stove, and lighted by electricity. The E.P.I.P. hospital tents should be lined with a chrome yellow-coloured material. The huts inside might with advantage be washed with this colour also, as it is cleanly in appearance and disliked by mosquitos."

"Portable huts are more desirable for active service than those permanently fixed; they are easier of transport, more rapidly erected and removed for re-erection for further use. Those used in the early months of the late war for hospital wards were too narrow, being only 17 feet 7 inches wide; the windows, swinging on a central pivot, and the eave ventilation arrangements were primitive and unsatisfactory,

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allowing free entrance of dust and causing draughts. The windows would be better made in halves (casement pattern), each half hinged to the side frames, so that either side could be opened and closed as desired; and the ventilators arranged by sliding panels over perforated zinc openings, one below and above each window. This would keep dust out, and the ingress and egress of air could be easily regulated. There should also be ample ridge ventilation, well protected from entrance of rain."

Ward Huts.

The Committee have recommended a standard pattern hospital hut for use as a ward on the following plan :—

Outside dimensions—length 84 feet, width 21 feet, height to eaves 8 feet, to ridge 15 feet. To have at one end two small rooms, 9′ × 6′, leaving the length for ward use 78 feet. Verandah at one end, 21′ × 12′.

It should have five windows at each side, each made in two halves (casement principle, and fastened on sill with bar fasteners), measuring 4′ × 3′. These should be so placed as to allow room for two bedsteads between each two windows. The doorways should be 3 feet wide.

The huts to be used as follows :—

(1) *Ward for* 20 *patients*, giving per patient, superficial area 80 square feet, cubic space 1,030 cubic feet.

One small room at the end for Sisters' linen store and pantry, etc.; with a linen press 8′ high by 4′ wide for spare hospital linen (ward and personnel), etc.; also a fixed perforated zinc safe, 2′ wide by 6′ high, to keep nourishment in, free from dust, flies, and other impurities. A small refrigerator, 2½′ × 1½′, should also be supplied for this.

Another small room for ward necessities, cleaning articles, etc., under charge of the ward orderly; with a suitable locker with shelves (6′ × 3′ × 1½′), for keeping bed-pans, urinals, chambers, spit-cups, other ward utensils and cleaning articles.

(The number of ward huts that would be, therefore, necessary for a 600 bedded hospital would be 30 for warrant, N.C. officers, and men).

(2) *Ward for* 18 *Officers*, subdivided by partitions into three smaller wards, holding six beds each. Other arrangements as in (1).

(3) *Ward for special cases*, or for senior officers, subdivided into ten small rooms, 15′ × 9′ × 8′, five on each side, separated by a central passage (3 feet). Other arrangements as in (1).

(4) *Sick Officers' dining and sitting room*, subdivided by one partition, giving two rooms 39′ × 21′ × 8′. Small rooms at the end to be used, one as a pantry with sink, cupboards, and shelves, the other for serving meals from.

Two 6′ × 4′ × 1½′ cupboards to be fitted in the dining room.

Furniture for these rooms to be included in the ordnance equipment of the hospital.

Accessory Buildings.

The Committee say :—

"The accessory buildings necessary for a general hospital at the base should be constructed of wooden frames and galvanised-iron walls and

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roof, with matchboarding lining, ample ridge and side-wall ventilation being provided.

A list is appended with a short description of each:

1. Hospital clean linen store
   „ foul linen store } in one hut.
2. Steward's provision store
   Utensil store
   Quartermaster's office (for two) } in one hut.
3. Pack store and rifle room.
4. Hospital kitchen
   „ milk kitchen, sterilising
   Meat store
   Scullery
   Shed for Soyer's stoves (8)
   Coal store } in one hut with accessory.
5. Patients' bath house (12 baths).
6. Lavatories (3).
7. Latrines (7).
8. Operating theatre with, in annexe, X-ray photographic room and sterilising room.
9. Dispensary
   Pathological laboratory
   Nursing Sister's duty room } in one hut.
10. P.M.O.'s office
    Registrar's office
    Post office
    Orderly Medical Officer's room } in one hut.
11. Medical Officer's kitchen.
12. Nursing Sister's mess hut.
13. Disinfecting sheds, including steriliser and incinerator.
14. Oil and lamp storeroom.
15. Reading room and chapel.
16. Clothing store, for supply to patients in hospital
    Red Cross store, for patients leaving hospital } in one hut.
17. Canteen.
18. Fowl run and hen coop.
19. Ashpits.

1. "The hospital *Clean-Linen Store* (50′ × 21′ × 10′) and the *Foul-Linen Store* (14′ × 21′ × 10′) are placed in one hut with partition to the roof. The clean linen store should have three 2-feet wide shelves all round and a double-rack standard shelving down the centre, with a wooden floor; also a serving counter 12′ × 2′ × 3′, about 6 feet from doorway. The foul-linen store requires no shelving; its floor should be of concrete.

2. "The *Steward's Store* (34′ × 21′ × 10′), the *Utensil Store* (20′ × 21′ × 10′), and the *Quartermaster's Office* (10′ × 21′ × 10′) are placed in one hut (64′ × 21′ × 10′), divided by wooden partitions into three compartments.

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"The *Steward's Store* should also be separated into two by a wooden partition, one part for a store, the other for an issuing department, with communicating doorway between. It should have a concrete floor. The issuing department should be fitted with three rows of 1½-feet shelving round three sides, and a serving counter, 12′ × 2′ × 3′ high, about 6 feet from doorway; also two specially constructed strong cupboards, which should be fixtures, for safe custody of wines and spirits.

"The *Utensil Store* should also have 2-feet shelving fitted all round, and a concrete floor.

"The *Quartermaster's Office*, situated at end of hut, should have three short shelves and two cupboards for safe preservation of documents and books. Its floor ought to be of wood.

3. "The *Pack Store* (56′ × 21′ × 10′) and *Rifle Room* (8′ × 21′ × 10′) are placed in one hut (64′ × 21′ × 10′), divided by a wooden partition. The former should be fitted with three rows of 2-feet wide shelving (2 feet apart) all round, except at windows and doors; and two standard double racks, with four rows of shelving, 2 feet wide, down the centre, with a passage between, 3 feet wide. This will give ample accommodation for 600 kits.

"The *Rifle Room* should have stands for a double row of rifles all round, both on walls and floor, and a window at each side. It would be better if each stand was lettered and numbered. Ample light and ventilation should be provided by four windows, 4′ × 3′; the floor should be concrete, both in pack and rifle stores, to allow of their being washed out with disinfectants frequently.

4. "The *Kitchen*, situated between medical and surgical divisions, and equidistant from all, should occupy a central position. It, however, should be sufficiently remote, say 50 yards from them, to render danger from fire impossible. In this position it is easily accessible for supply carts, etc., and sufficiently distant from hospital wards for a drainage system from scullery to be established. It should consist of one hut (64′ × 21′ × 10′), divided into general kitchen (52′ × 21′ × 10′) and milk (dairy and sterilising) kitchen (12′ × 21′ × 10′), the former fitted with four large ranges, situated in the centre of the kitchen (back to back is the best arrangement for them), with a central chimney. We think that four large ranges should prove sufficient; but, if not, two more can be easily added, one at each end, crosswise. Hot water boilers should be attached to each range, and accumulation circulatory cylinders for the supply of hot water to scullery and 12 baths. A hot plate for 500 diets should be fitted at one end, and cupboard lockers and drawers (the top of which would form kitchen tables) fixed for storing cooking necessities, etc. The floor should be of concrete. Sliding counters should be attached to two windows for serving dinners through. Four windows, 4′ × 6′, three in front wall and one in end wall, should give ample light. The entrance door should be divided horizontally about 3 feet from ground, for entrance of more air and light if necessary.

"The *Milk Kitchen* is situated at end of hospital kitchen. It measures 12′ × 21′ × 10′, has room for six to eight sterilisers if necessary, and should be fitted with stone shelves for standing milk on to cool. It is lighted

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by a window, size 6′ × 4′, situated in gable wall. The entrance door should be divided horizontally to allow of more air and light if necessary; also to act as an issuing counter. The floor ought to be of concrete.

An annexe, constructed as a lean-to hut against the posterior wall of kitchen, inside wall 10 feet high, outside wall 9 feet, size 64′ × 10′ × 9′, divided as follows:—A *meat store* (*larder*), 12′ × 10′ × 9′; a *scullery*, 20′ × 10′ × 9′; a *Soyer's stove shed*, 20′ × 10′ × 9′; a *coal store*, 12′ × 10′ × 9′.

The *Meat Store* should have one door, 3 feet wide, opening from outside, and two large perforated zinc windows, 4′ × 3′, to allow of free admission of cool air but no flies. It should be fitted with a butcher's bench and strong hooks for hanging carcases on. In this store all the meat is cut up before being brought into kitchen for cooking. The floor should be of concrete, and frequently washed out with disinfectants, and the inside of the walls frequently whitewashed.

"The *Scullery* (20′ × 10′ × 9′) should have a long porcelain or metal washing trough down the centre or one side, for washing plates, pots, saucepans, etc.; and a double row of shelves along one side and two ends for keeping them on when clean. Its supply of hot water should come from the kitchen accumulator. Its floor should be concreted. There should be a communicating door between kitchen and scullery; also one opening outside.

"The *Shed for Soyer's stoves* (or, better still, agricultural or cattle food boilers) should have a communicating door to kitchen. Its size has been planned to hold eight of the boilers, which proved far more serviceable after prolonged use than the ordinary Soyer's stoves for boiling vegetables, meat, water, etc. We suggest those fixed on wheels as better for movement. The floors ought to be concreted; there should also be a door opening outside. The chimneys from boilers can pass direct through roof.

"The *Coal Store* (12′ × 10′) ought only to have one door of entrance, and that from outside; and no communication between it and kitchen on account of ingress of coal dust, and no windows. It is capable of holding four tons of coal; this is the main coal supply for the whole hospital. Its floor ought to be of concrete.

5. "The *Baths*, 12 in number, which is considered sufficient, are situated in a hut adjacent to the kitchen for hot water supply, near centre of hospital for convenience of patients, and in cross roads, being adjacent to drainage scheme. A doubled span hut (30′ × 21′ × 8′ at eaves) with a double row of six baths, arranged in cubicle partitions 8 feet high, containing a 7-foot bath and seat in each. The hot water supply should be laid on by pipes from kitchen, fitted with tap to each bath. By this arrangement there is a constant supply of hot water, day and night, which could not be if they were situated elsewhere in the camp, unless a specially designed boiler house was erected in connection with baths. A cold water supply also to be laid on by pipes—one tap to each bath. The branch drain pipes from scullery and bath house should lead direct into the main drain, being properly trapped. The floors of bath rooms and passages should be of concrete, slightly sloping outwards, where a

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surface drain should take the surplus water and washings from floor (which should be carried out daily); scrupulous cleanliness should be observed in all other respects.

6. "The *Lavatories*, three in number, two for patients and one for Detachment R.A.M.C.; each 40′ × 15′ × 8′. Those for the patients should be situated, one at outer side of both the surgical and medical divisions, about 50 yards distant, and in a line with the latrines; having one door for admission and four windows, two at each side; a washing-stand table with a 1-inch edging all round to prevent overflow, constructed of wood and covered with zinc, 30′ × 5′, 3 feet high, sloping slightly from the sides to the centre, which is hollowed to form a drain, which carries the water to one end, then down a 2-inch discharge pipe to the branch drain (leading to the main), which should be properly trapped outside the hut. The water supply is arranged by a pipe passing from one end of table to the other, about its centre. This is fitted with 30 branch taps, 15 at each side, arranged alternately. A concrete floor, 4 inches thick, is necessary; also a strong wooden trellis, 1 yard wide, for standing on, placed round the wash tables. Each wash-house ought to have 30 zinc or enamelled-iron washing basins.

7. "The *Latrines*, seven in number, as follows:—3 for patients, 1 for Officers' hospital, 1 for Detachment R.A.M.C., 1 for Medical Officers' camp, 1 for Nursing Sisters' camp.

"The patients' latrines, three in number, two being 45′ × 18′ in size, consist of a galvanised iron screen down the centre, on one side of which accommodation for a single row of 20 seats is provided, being roofed only over the seats to allow free circulation of air. A protection wall, which is included in measurements, surrounds the whole except for the entrance doorways at both ends.

"The opening in posterior wall is for conservancy men to come and go, a space 6 feet wide being allowed inside this wall for spare buckets and others for emptying bed-pans, urinals, and slops from wards into. In this space is also kept the supply of disinfectants necessary for use, the conservancy being done from the back of the seats, over the openings for which hinged doors should hang to prevent draught and blowing about of latrine paper. The whole floor should be of concrete, 4 inches thick, to allow of daily washing and disinfection. Two seats should be partitioned off and marked 'For venereal patients' use only.' Boxes as fixtures for latrine paper are necessary.

"The third patients' latrine, intended only for convalescent enteric fever patients (placed about 50 yards from the side of that division and containing only six seats), is designed and constructed like the other latrines; all the excreta and liquid slops brought from wards to this latrine are disinfected.

"The three small latrines (12′ × 12′) for sick Officers, Medical Officers, and Nursing Sisters' use, consist of three seats each, and are of same design, except with partitions between each seat and doorways for privacy. A urine tub stands in the corner of the two former.

"We have allowed an average of 20 seats for each division of 200 beds (10 patients per seat), except for the enteric division, for which

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latrine accommodation for 60 convalescents, *i.e.*, about one-third of the beds, has been provided.

"The latrine for Detachment R.A.M.C. should be the same in design as that for the patients, only that four seats should be partitioned off for N.C. Officers. Its position should be about 50 yards from inner flank of their camp, behind patients' latrine. Boxes of dry earth and scoops should be placed in each.

"*Urinals.*—Four soil buckets are placed in each front corner of latrine enclosure. These are partitioned off for privacy. These would, of course, be unnecessary if a system of drainage was laid down, which for prolonged occupation is considered advisable. The dry-earth system is the one advocated. A small shed should be supplied for storing the dry earth in; removal of the pails to take place morning and evening. The strictest attention to cleanliness is necessary; floors and seats should be washed down with disinfectant solutions; pine-wood sawdust or carbolic powder and dry sand sprinkled over the floor daily, the inside walls being limewashed at frequent intervals."

[NOTE.—The drainage system is not very clearly defined. It should certainly be a surface system only. Pipe drains are troublesome and dangerous unless well and carefully laid, and it is not probable that this could be satisfactorily done in a service hospital.]

8. "*Operating Theatre.*—This should also be constructed of a wooden frame, with galvanised iron roof and sides and matchboard lining to same; size 25′ × 25′ × 10′ walls. It should have two roof lights, 6′ × 4′, with green-coloured drawn blinds, three sides having two windows, each 6′ × 4′; the fourth side has the X-ray photographic and sterilising room attached as annexe.

"The walls should be covered with white enamel paint, two coats, to prevent absorption, and to enable them to be washed with disinfectants when necessary. The white colour also tends to lighten the room. The floor should be covered with thick linoleum all over, to prevent absorption, as also to allow of its being washed with disinfectants. Green roller blinds should be fixed in all the windows, the lower sashes of which ought to have dulled glass. The entrance door, as well as that the X-ray room, should be 4 feet wide, to allow ample room for stretchers with attendants. Four ventilators, sliding panels over perforated zinc, should be placed in the walls. Two powerful hanging kerosene oil lamps, of 100 candle power (if electric light is not procurable), are required for night work; also two small hand lamps with reflectors, for throwing light on the patient. In several of the general hospitals in South Africa portable electric lamps of 20 candle power were used for this purpose with very good effect. An ample supply of hot and cold water should be laid on, with taps over sink and hand basins. These should discharge into a portable cistern outside, which could be emptied as required.

"The *X-ray and Photographic Room*, if not under the same roof, should form, with *Sterilising Room*, an annexe to the operating theatre, having a door of communication between; their size 20′ × 15′, with a partition dividing 5′ × 15′ off, to form the dark room for photography. The dark

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room requires a red glass window, 1½ feet square; also a sink and three rows of shelving all round.

"The X-ray room, in which there is ample space, should also be used for administering anæsthetics to patients." [NOTE.—It is better to have a separate room for this purpose.]

"A room 5′ × 15′ × 8′, for sterilising dressings, towels, etc., forms portion of the annexe, with communicating door to the operating theatre. It is a convenience that cannot well be done without, and should contain a cupboard 6′ × 4′ × 1½′ for surgical dressings, towels, etc., under care of the nursing Sister.

9. "The *Dispensary* (28′ × 21′ × 8′), the *Pathological Laboratory* (20′ × 21′ × 8′), and the *night Sisters' Duty Room* (16′ × 21′ × 8′) will form another hut 64′ × 21′ × 8′.

"The *Dispensary* should have a 10′ × 6′ room partitioned off in one corner for keeping splints in (this ought to be provided with three rows of shelving, 1½ feet wide, all round); a poison cupboard, 6′ × 3′, at one corner, for safe keeping of poisons, with four shelves; a dispensing counter across room, within 4 feet of entrance door; an enamelled iron or porcelain sink at one corner, which should discharge through wall into a portable cistern outside; and four rows of shelving all round.

"The *Pathological and Bacteriological Laboratory*, situated at one end of hut, should have three windows, 6′ × 3′, to afford plenty of light, and locker cupboards, 3 feet high, along the window sides; also a porcelain sink and hand basin fixed in one corner, which should discharge through wall into a portable cistern outside. This room requires ample ventilation, ridge and wall.

"The *night Sisters' Duty Room* is very necessary for the comfort of these ladies doing night duty, especially during inclement weather. Armchairs, table, hanging lamp, and an oil stove for preparation of nourishment, also cupboards for medicines, stimulants, etc., are all the fittings necessary.

10. "*Principal Medical Officer's and Registrar's Offices, Post Office,* and *Orderly Medical Officer's room.*

"The situation of the hut should be fairly central and convenient to all divisions for purposes of administration.

"Sizes—P.M.O.'s office ... ...
Registrar's office ... ...
Sergeant-major's and clerk's office ...
Registrar's and pay clerk's office ...
Post office ... ...
Orderly M.O.'s room ... ...
} each 15′ × 12′ × 8′.

"They should be all separate, with communicating doors between the first four.

"*Telephonic communication* should be laid on to the sergeant-major's office from the principal hospital centres, viz.: Quartermaster's and Divisional Officer's offices.

12. "*Nursing Sisters' Quarters.*—Nursing Sisters, whether living in huts at base or in tents with advanced hospitals, should always have, if

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possible, a mess hut, consisting of sitting room, dining room, kitchen, scullery, and pantry.

"The one suggested measures 64′ × 21′ × 8′, with rooms as follows:—sitting room, 20′ × 21′ × 8′; dining room, 24′ × 21′ × 8′; kitchen, 20′ × 10½′ × 8′; scullery and pantry, each 10′ × 10½′ × 8′. A large range should be fixed in the kitchen, also dressers and lockers. A sink in the scullery, which, like those in other huts, can discharge into a portable cistern outside the hut wall. The pantry would require a locker press for stores.

"At the base the ladies ought to be housed in huts. One constructed on same plan as that shown for sick officers, 'single room hut,' would give very suitable rooms; 14′ × 9′ × 8′ would give accommodation for 6 on each side—12 ladies in one hut. Three such huts would be required, allowing for 34 sisters; this would give one spare room. The two end rooms in one hut should have a partition instead of a 3-foot passage between them to serve as chief matron's sitting and bedroom; the passage at further end of other huts could be used for box rooms. A small extra hut would have to be provided for one housekeeper and three servants.

"In base hospitals, *the Medical Officers' mess hut* should be similar in design and size to the one for the Nursing Sisters.

"If sleeping huts are necessary, those already described form very comfortable accommodation.

[NOTE.—Hut accommodation for the staff will only be required under very exceptional circumstances, and need hardly be considered.]

13. "*Disinfecting Sheds.*—The disinfecting sheds—two in number, one for soiled clothes, the other for infected discharges—should be situated close to one another, and about 50 yards from the outer flank of infectious division, constructed of similar materials as other huts, but without matchboard lining.

"That for *infectious clothes*, size 55′ × 15′ × 10′, should consist of three divisions—

(1) 15′ × 15′ × 10′, where all clothes are steeped in chemical disinfecting solutions and wrung out.
(2) 15′ × 15′ × 10′, where the fœcal soiled clothes and others requiring it are boiled.
(3) 25′ × 15′ × 10′, for Thresh's steam disinfecting apparatus.

"The floor of this entire shed should be of concrete, 4 inches thick.

"The first should have three wooden tubs, about 3′ × 3′ in size, with a wooden tap in each, close to the bottom, for emptying them. They should be raised on 6-inch concrete platforms, and ought to be placed three on each side of lower half of shed. A small open drain, commencing at first tub each side, made in the concrete, in connection with a portable cistern sunk at back of hut, is also necessary if main system of drainage does not exist. A low partition, 3 feet high, should separate No. 1 shed from No. 2, to allow of clothes which have been chemically disinfected and require boiling being passed into No. 2 shed for that purpose.

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"No. 2 division requires two large size (100 gallon) boilers with cocks. The chimneys should pass through the side walls and extend about 4 feet above the roof.

"No. 3 division should have a large size steam disinfecting apparatus with a door at each end, one for entrance of infected clothing, the other for exit of disinfected. (The Thresh's apparatus supplied to hospitals in South Africa was not large enough for requirements.) A partition should completely divide this shed into two, one for infected, the other for disinfected clothing. The chimney should pass through and extend 4 feet above the roof.

"A small lean-to shed at end of this division as coal cellar is also necessary.

"*Excreta and Slops.*—The second shed, for disinfection and sterilisation of all infected discharges and slops from infectious division, etc. (size 25′ × 15′ × 10′), should have a sink in one corner, drained into a cistern outside at back of hut, for washing bed-pans and urinals in after chemical disinfection. At one end of hut a large 100-gallon (or 150-gallon) ordinary boiler, set in brick fireplace, should be erected, with chimney built outside, for sterilising all infected discharges and slops. The walls all round should only extend 6 feet high, leaving a space of 1 foot below to allow for free circulation of air.

"The clothes boiler, excreta steriliser, and outside cisterns should be emptied by hand buckets into sanitary carts as frequently as necessity demands. All these sheds should be limewashed inside frequently, and floors washed with disinfectants daily.

"*An Incinerator*, for burning used dressings, infected and worn-out clothing, and all refuse generally found in camps, is a necessity. This can easily be constructed for dry materials. An ordinary covered furnace with good draught is all that is required.

"The combination steriliser and incinerator as used in No. 4 General Hospital (which is reported on as satisfactory in every respect) is practically a steriliser (as far as destruction of liquid excreta is concerned), for the heating of which dry camp refuse, infected and old clothing, etc., was used as fuel. This is an excellent plan, as both processes being performed by the one furnace fuel is saved, and the mixing of dry absorbents to render liquids semi-solid is not required. This is an appliance worthy of imitation and reproduction."

[NOTE.—The chief advantage of this method of sterilising excreta by heat is that it disposes at once of the urine and other fluids, and that it can be easily improvised on a small scale. But incinerators were used at many of the General Hospitals, and when constructed of proper material worked well. The difficulties were chiefly due to subsidence and cracking, the results of faulty construction. These were, of course, most successful where it was found possible to use solid material to mix with the fluids, but in many places there was no difficulty about this. At No. 2 General Hospital and at No. 20 these incinerators worked particularly well. The Committee, however, prefer boiling on account of the difficulty about fluids.]

"If a satisfactory portable appliance, combining in one both steriliser

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and incinerator, could be designed of a sufficiently light weight (say, between 1 and 2 tons) for horse draught, it would be of great advantage to field, stationary, and advanced general hospitals.

"The fire chamber should be of large size, probably lined with specially shaped fireclay blocks, and the boiler capable of holding about 100 gallons, so set in fire chamber that the flames should play all round under surface and sides.

"It would be advisable to have the whole of disinfecting, sterilising, and incinerating appliances surrounded by an 8 feet high corrugated iron fencing. Its size would necessarily depend on the size of enclosed buildings and appliances, and it should be floored with concrete.

14. *Oil and Lamp Store Room.*—"A small shed, 12′ × 12′ × 8′, for storage of paraffin oil and trimming all hospital lamps is required. Its position should be central, and near the quartermaster's stores, under whose care it would be.

15. "A hut, to act as *Chapel*, *Library*, *Reading* and *Writing Room*, would be a convenience both to patients and hospital personnel. A suitable one would be a hospital ward hut, but without partitions or small rooms, size 84′ × 21′ × 10′.

16. "A hut, the same size and shape as the clean and foul linen store, divided into two, with two rows of shelving all round both rooms, and counters across near the doorways, would form all that is necessary for a *Red Cross* and *Clothing Stores*, if still considered necessary for the R.A.M.C. to perform these duties.

17. "Huts in place of tents for *Canteen* (dry and wet) and filters, also sheds for carpenter, tailor, sailmaker, shoemaker, and barber's shops, if not absolutely necessary, are very desirable.

18. "*A fowl-house and run*, size about 24′ × 8′ × 8′ inclusive, is a necessity when live fowls are supplied, as they were in South Africa.

19. "*Ash-pits.*—Two are necessary, each 12′ × 12′ × 6′ (one side being removable), constructed of galvanised iron, and floored with concrete.

"*Railway Siding.*—General and Stationary Hospitals should be erected as close as possible to the railway line, for convenience in transferring sick and wounded. If a suitable site cannot be obtained, a railway siding, with platform, should be constructed (as early as possible) to the hospital for its use. Size of platform 150′ × 12′, with a ramp 18 feet wide."

GENERAL SCHEME OF HOSPITAL CAMP.

The Committee say:—

"The laying out of a Hospital Camp must necessarily vary according to local conditions (size and formation of ground available) and the military considerations. For administrative purposes the principal accessory buildings, stores, offices, etc., had better occupy a central position. A scheme will be best understood by reference to attached plan, which includes three divisions, Surgical, Medical, and Infectious (enteric), and an Officer's hospital.

"In the central road of the hospital, which is 40 yards wide, are placed

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the administrative offices and other buildings, consisting of (enumerating from front of hospital):—

"Day wardmaster and duty room. Dentists' consulting room. Principal Medical Officer's, Registrar's and their clerks' offices; Orderly Medical Officer's room; Post Office. Operating theatre, with X-ray room. Pathological laboratory; dispensary, night Sisters' duty room (for the whole hospital). Red Cross and clothing stores. Kitchen. Filter hut. Lamp and oil store. Barber's shop; electrician's shop. Tailor's, sailmaker's, and shoemaker's workshops. The fowl run and carpenter's workshop lying behind the hospital.

"In the cross avenue, which is also 40 yards wide, are placed:—soiled and clean linen stores; stewards' and utensil stores and quartermaster's office; baths, pack store and rifle room; and chapel.

"The kitchen, including milk kitchen, with sterilisers, larder, scullery, Soyer's boiler room, and coal cellar, occupies the centre of the hospital, about 50 yards distant from each division. Behind the kitchen is the filter hut and lamp room, which must occupy a central position for supply of drinking water and for trimming of all hospital lamps.

"At each side of central avenue in front, are placed the surgical and medical divisions, the infectious being over 50 yards behind the medical. Each is estimated to contain 200 patients, but is capable of expansion if necessary. The Officers' hospital lies behind the surgical division, separated from it about the same distance.

"All the tents (enlarged E.P.I.P.*) in the three divisions are calculated to hold 10 patients; those in the Officers' hospital (small E.P.I.P.) four patients each.

"The Surgical Division requires less bed accommodation generally on active service than either of the others, but this must be arranged, by expansion or contraction, as circumstances demand.

"Tents should be reserved for serious cases requiring special nursing, one tent for opthalmic (surgical) patients; the last row of tents ought to be set apart for venereal patients. The Divisional Officer's office and Nursing Sisters' duty rooms are placed on inner flank of division. The latrines and wash-houses are on the outer flank, about 50 yards distant. The prisoners' tent can be pitched when necessary at the back of division, where sentries can be posted without inconvenience. The operating theatre is in close proximity to the division.

"The Medical Division should also have tents set apart for serious cases requiring special nursing and for tuberculosis patients. The Divisional Officer's office and nursing Sisters' duty tents are placed as in the surgical division, also the latrines and wash-houses on outer flank.

"The Infectious Division, which includes a camp for isolation cases, is also equipped for 200 patients, but is designed for expansion or contraction as circumstances demand. The first four rows of tents, with 160 beds, are for the treatment of enteric fever. The last row—40 beds—for dysentery.

"The Isolation Camp should be behind and well apart from the

* European Privates Indian Pattern.

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infectious division; the tents, being double circular, are pitched and struck as occasion requires. The Divisional Officer's office and nursing Sisters' duty tents are situated on inner flank as in other divisions.

"All the disinfecting arrangements are situated in an enclosure on outer flank, 50 yards distant, in or near which is also the incinerator.

"The ashbins are also placed behind the enclosure, out of sight and near to incinerator.

"The mortuary is situated about 100 yards behind the disinfecting enclosure, out of view of the hospital.

"The Officers' Hospital is practically a distinct unit in itself, having messing and sitting tents, ward tents, Divisional Officer's office, kitchen, lavatories, latrines, wardmaster's and orderly's duty tent; also a Nursing Sisters' pantry, The front row is formed of two tents, one a mess the other a sitting room. The second row has three tents, each containing four beds for medical cases. The third row has three tents, with 10 beds—eight for surgical cases, and two in one as a ward for special cases. The latrines and bath room, also kitchen, are places on one flank. In a General Hospital at the base officers should be accommodated in huts. In advance base hospitals a mess hut should be provided.

"The Medical Officers' Camp is situated to the left front of the hospital; and consists either of a hut, containing mess, sitting room, kitchen, scullery, and pantry, or of two E.P.I.P. tents of large size as mess and sitting room, 22 officers having to be accommodated. The living tents (which should be the Indian Field Officers' tent with bath attachment) are placed in rows adjacent to the mess.

"If a hut is not provided a kitchen with scullery and pantry should be erected.

"The latrine is placed to right of camp about 25 yards distant.

"The Nursing Sisters' Camp, situated to the right front of hospital, should consist of a hut combining mess and sitting rooms, kitchens, scullery, and pantry. If hut cannot be provided two E.P.I.P. tents, large size, are necessary, also a kitchen, scullery, and pantry, built as in Officers' camp. The living tents recommended for these ladies' use are the Indian Field Officers' tent, with bath attachment. These would be far more comfortable and convenient for them than the double circular. Each nurse should have a tent to herself. The latrine is situated about 50 yards to the left of camp. In General Hospitals at base we recommend that Nursing Sisters live in huts.

"The Royal Army Medical Corps Camp is placed on the left flank of the hospital. It is also a self-contained unit, having cookhouse and scullery, lavatory, wash-house and latrine. The former is large enough for the double duty of cooking for the detachment's and sergeants' messes. It is situated behind their camp, about 50 yards distant.

"In the front row of tents are the canteen, sergeants' mess, and Warrant Officers' quarters, the N.C. Officers' tents being on outer flank. The canteen had better be a small hut (12′ × 12′) for safe custody of supplies. The latrines and wash-house lie to the inner side of camp (about 50 yards distant), with their backs to the patients' latrine and wash-house."

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SOME WORK BY THE ELECTRICAL ENGINEERS, R.E. (Vols.).*

The Irish Manœuvres, 1905.

These manœuvres, to which the Corps was asked to send a detachment with a field search light, took place at Glen Imaal, co. Wicklow, on the 16th and 17th August.

The "General Idea" of the operations was that a Fortress (Blue), protected by works on the mountain of Lugnaquilla and the ridges to the north of it, had been invested by an Attacking Force (Red) and gradually driven back to the last line of advanced works covering the main position. A final attack on these works was commenced on the morning of the 16th, and was intended to last about three days.

The Red Force consisted of a division of infantry, several artillery brigades, amounting to about eighty guns, and two field companies of engineers.

Elaborate defences, consisting of redoubts, splinter proofs, trenches, and wire entanglements, had been constructed to mark the positions occupied by the Blue or Defending Force; and as live projectiles were used by the attack, these fieldworks were "manned" by dummy targets. The effect of the artillery and infantry fire of the attacking force could thus be duly noted.

Extensive use was made of field telephones, the movements of all the artillery and infantry being controlled by their means from the headquarters of the attack.

A Detachment of Electrical Engineers (Vols.), commanded by Capt. J. J. F. O'Shaughnessy and consisting of C.S.M. W. J. Grey and 16 N.C.O.s and men, left London by the 10.15 p.m. train on Monday, the 14th August, and proceeded *viâ* Holyhead and Dublin to Dunlavin, co. Wicklow. From there they marched 9 miles to the camp of the 57th Co., R.E., at Coolmoney, the headquarters of the Red Force, where they arrived on the evening of the 15th.

The plant, consisting of one of the portable Daimler-Schuckert oil engine sets, field projector, and cable cart, had been sent off in advance by goods train, and was awaiting the arrival of the Detachment at North Wall, Dublin. Corpl. T. Vitty and one sapper were detailed to accompany the search-light train, which was taken by road by a six-horse R.E. team to Coolmoney, a distance of about 40 miles, and arrived at the camp some few hours after the remainder of the Detachment.

The forenoon of the 16th inst. was spent in overhauling the plant, while the O.C. Detachment accompanied Colonel Scott-Moncrieff, R.E., the Commanding Royal Engineer, in a reconnaissance of the proposed

* Reprinted, by permission, from *The Sapper* of December, 1905, and January, 1906.

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position for running the light. This was a redoubt, supposed still to be in the hands of the enemy, but which was expected to be captured and held before nightfall as an outpost of the attack.

At 1.30 in the afternoon the Detachment moved off, escorting the balloon cart and search-light train. Owing to the hilly nature of the ground to be traversed, the latter was provided with an eight-horse team. A halt was made at Leitrim Castle, the headquarters of the 7th Division, where the search-light train remained until nightfall and opportunity was taken to have a trial run of the engine. During this run the Detachment was inspected at work by General Lord Grenfell, Commander-in-Chief of the Forces in Ireland, and also by Lieut.-General Sir G. de C. Morton, Commanding the 7th Division, who both expressed their satisfaction and thanked the O.C. for the services of the Detachment.

A party of seven sappers were detailed by the O.C. to assist the Corporal, R.E., in charge of the signal balloon, and proved their adaptability by assisting to inflate and handle same.

At 8.30 p.m. the party moved off to take up their position on Mill Hill Redoubt, crossing a ford and negotiating a very steep hill *en route*. On arrival at the base of the position the engine was run into the shelter of a ruined house and left to the care of Corpl. Vitty and 2nd Corpl. Templeman, who had the engine running at full voltage long before it was required. The projector and cable cart were meanwhile separately man-handled with double ropes by 14 E.E.s up an exceedingly steep hill, covered in many places with large boulders; and the light was running on top of the position 25 minutes after the search-light train arrived at the foot of the hill. This was an exceedingly creditable performance, considering the difficulty of the hill which had to be negotiated and that over 400 yards of cable had to be paid out.

The light was used very effectively to illuminate surprise targets, which were occasionally raised and depressed to represent a counter-attack on the hill. The infantry, stationed at the outpost, were instructed to keep up a hot fire on the targets when exposed. The experiments, which were carried out in the presence of the general and his staff, proved that with a 24-inch projector these targets, which were about 3 feet square, were sufficiently illuminated by a 16° dispersed beam for effective rifle fire at 600 yards and by a concentrated beam for effective fire at 1,000 yards.

After the firing had ceased the projector and cable cart were lowered down the hill by drag ropes, the search-light train coupled up, and the Detachment marched off to camp, a distance of about 5 miles, where they arrived at 3 a.m. The search-light train was left *en route* at Leitrim Castle, ready for the next day's operations.

On the following day, the 17th, the Detachment marched to Leitrim Castle about 1 p.m., in order to prepare for the night run, which was to have taken place on Cannow Mountain, and which, owing to the difficult nature of the ground to be traversed, would have necessitated the use of a ten-horse team for the search-light train.

Unfortunately, however, heavy rain having set in, the G.O.C. ordered that the operations were to cease at sunset, and not to continue over next

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day, as originally intended. As an alternative to the run on Cannow Mountain, it was suggested by the O.C., E.E., that, if the weather improved before nightfall, the E.E.s should give a demonstration of the light from Leitrim in illuminating men attacking in extended order, but this had reluctantly to be abandoned owing to the severity of the weather.

THE CHARING CROSS RAILWAY STATION DISASTER.

About 4.0 p.m. on the afternoon of 5th December, 1905, a large portion of the outer end of the arched roof of Charing Cross railway station, London, suddenly collapsed.

At 6.50 p.m. a Detachment of the Electrical Engineers (Vols.) was telephoned for to bring their search lights from their headquarters in Westminster to enable the repair work to go on. Before 8 p.m. 25 men and two field search lights were on the spot, under the command of Capt. J. J. F. Phillips and Lieut. E. G. Sheppard. A few minutes later the projectors were mounted on top of railway carriages, and the lights concentrated on the places where the repair work was going on, thus enabling very risky work, which would otherwise have been delayed till daylight, to proceed without a break.

This lighting was continued by the corps every night as long as required.

It is very creditable to the corps that at so short notice they were able to carry out the whole of this work entirely unaided, more especially as the men were not in any way picked, but were simply those who happened to be at headquarters for drill.

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REVIEW.

THE BATTLE OF WAVRE AND GROUCHY'S RETREAT.

By W. Hyde Kelly, R.E.—(Murray. 1905).

Lieut. Kelly has chosen a good subject and has handled it well. The campaign of 1815 is always attractive, and this particular episode of it is comparatively unfamiliar to English readers. It was mid-day on the 17th of June when Grouchy took command of his two corps to follow the Prussians; it was mid-day on the 19th when he began his well-executed retreat from Wavre, on learning the result of the battle of Waterloo. How he carried out his task during these forty-eight hours has been the subject of infinite discussion, and the problems presented are of great interest. Facts rather than judgments are what the reader wants in order to form an opinion on these problems, and the facts cannot be too fully stated. In this respect the histories of the Napoleonic wars which are now being brought out by the French General Staff are models. Lieut. Kelly tells his story clearly and forcibly, but a larger part of his 150 pages might with advantage have been devoted to the facts, and less to criticism.

Some introduction was, of course, necessary, but it might have been brief; as it is, we find ourselves half through the volume before Grouchy starts on his mission. On page 78 we read:—

"Whatever may be said in extenuation of Napoleon's delay and inactivity on the morning of the 17th, the actual circumstances of the case did not warrant his wasting his time on the previous day's battlefield and discussing politics with his generals when all his energies should have been concentrated on the great crisis at hand."

Such a man as Napoleon should not be charged off-hand with wasting his time; he is entitled, like the meanest criminal, to the benefit of the doubt. We know that the battle of Ligny had ended after dark and that the French troops were short of ammunition, that the cavalry had been sent off at daybreak to ascertain by what roads the Prussians were retreating, and that the situation at Quatre Bras was still obscure. Whether Napoleon's inactivity was justified by these or other reasons is fair matter for discussion, but it should be thorough; and obviously it belongs to the general history of the campaign rather than to the Wavre episode.

In blaming Grouchy for not crossing the Dyle at Moustier and Ottignies when he heard the guns at Waterloo, Lieut. Kelly is in good

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company; but it is going far to say that Grouchy should never have allowed Blucher's flank march to St. Lambert to be carried out. "The cavalry could have reached the bridges (at Moustier and Ottignies) in time to threaten Blucher's flank, and prevent him, if not from assisting Wellington with a part of his forces, at least from throwing his whole weight into the battle against Napoleon." As a matter of fact only about 40,000 Prussians took part in the battle of Waterloo; and looking to the prolonged resistance which Thielemann made on the 19th, after Grouchy had passed the Dyle at Limah at nightfall on the 18th, it seems doubtful whether an earlier passage would have much affected the results.

E. M. LLOYD.

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NOTICES OF MAGAZINES.

Bulletin of the International Railway Congress.

November, 1905.

A Cheap Method of Interlocking Switches and Signals.—In the British Isles the concentration of point and signal operation is an accomplished fact on lines open to public traffic; but in other countries the installation of interlocking has not proceeded so rapidly in the case of wayside stations, and consideration of the expense has urged engineers to search for other methods whereby security can be attained at less cost.

Various methods involving bars and padlocks to switches, a central lock (as in the Bouré system), keys in the lever frame, which cannot be removed to unlock an outlying switch unless all conflicting signals are "on," Annett's lock, and various other lock and key arrangements have been tried, but are all a little cumbrous. Again, systems involving wire locking or rod locking have been installed occasionally. They save concentration of levers in a signal box, but involve a good deal of apparatus and are not wholly satisfactory. Besides, particularly at roadside stations, complications of wires are as well avoided.

The system herein described may be called "locking by electrical tappet," and the principle involved is that of mechanical locking by lock and key, controlled by quite simple electrical mechanism, while the key need not be taken from place to place, and no elaborate wire connections are necessary.

For switches the levers may be of very much the ordinary shunting or throw-over type, and for signals any kind of weighted lever would answer.

The electric tappet—or tumbler rather—on the lock consists essentially of a stop which secures the bolt of the lock in position when closed. When the lock is shut the tappet holds it normally, and a current must pass to free the apparatus. If the lock is unlocked the circuit is broken. To operate the circuit a push is pressed, and then if there is no break in the circuit the tappet, being lifted by an electro-magnet, releases the lock, the push being held down while the key is turned. Thus a Leclanché battery can be employed.

Hence, conflicting signal and switch levers being connected electrically, the throwing over of any one involves a break in the circuit and prevents any of the others being operated.

It is hardly possible to describe the apparatus in detail without the diagrams. I should mention, however, that in case of breakdown of the electrical arrangements the lock can be released after breaking a lead

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seal, and, according to regulations, this may only be done in the presence of the Station Master.

The system is extraordinarily cheap. Average cost per lock £1 to £1 4s. 0d. Average cost of equipment of a roadside station (13 locks) under £36.

A specimen station is instanced (Waterloo, on the Brussels-Charleroi line)—four crossover roads and two sidings—cost of interlocking 883 francs. The furthest switch is 450 mètres from signal levers.

C. E. VICKERS.

JOURNAL OF THE ROYAL ARTILLERY.*

December, 1905.

ARMY TRAINING FOR OFFICERS OF THE R.G.A.—Since the separation of the Garrison Artillery from the Horse and Field the former have become to a great extent specialists, and the officers are now apparently beginning to find themselves out of touch with the rest of the Army as regards work in the Field. Lieut.-Colonel F. G. Stone, R.G.A., draws attention to the drawbacks of this development, and what he says applies with equal force to officers engaged in some of the duties of the R.E.

"No officer in any branch of the Service is fit to rise to field rank unless he knows a great deal about the other branches and is capable of applying that knowledge in the field." "The R.G.A. should be fully and fitly represented, both in peace and war, on the Staff of the Army and . . . in appointments and commands which should be considered equally open to every branch of the Service—*remembering always that we are Garrison Artillerymen, but never forgetting that we are soldiers.*"

To counteract the tendency of specialization to put difficulties in the way of acquiring and maintaining general military knowledge, Colonel Stone lays stress on the necessity of R.G.A. officers seizing every opportunity of seeing the work of other troops. But he realizes that opportunities are not afforded as generously as they should be, and rightly argues that "it is desirable in the interests of the Regiment as a whole (and consequently in the interest of the Service) that the R.G.A. should be well represented at manœuvres and staff rides in which every arm of the Service is engaged." "Valuable instruction can be obtained by attaching Artillery officers as assistants to Infantry umpires, and *vice versâ*." "Let us realize fully the mutual advantage which may be derived from the close association of officers of the R.G.A. with those of other arms of the Service, and the salutary effect of never allowing ourselves or others to regard the R.G.A. as anything but an active fighting branch of the Service."

A. T. MOORE.

* Formerly the *Proceedings of the Royal Artillery Institution.*

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JOURNAL OF THE UNITED SERVICE INSTITUTION OF INDIA.

October, 1905.

This quarterly number contains a very great deal of instructive matter, the following articles being especially deserving of study:—

1. A COMPARATIVE STUDY OF THE ORGANIZATION, TRAINING, AND DUTIES OF THE STAFF IN THE ARMIES OF FRANCE, GERMANY, AND ENGLAND; WITH PROPOSALS DEDUCED THEREFROM FOR THE ORGANIZATION AND TRAINING OF THE STAFF SUITED TO IMPERIAL NEEDS (Gold Medal Prize Essay, 1905).—By Major G. R. Cockerill, Royal Warwickshire Regiment.

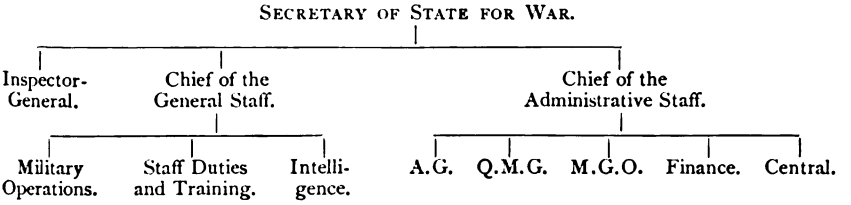
2. THE EDUCATION OF OFFICERS (Tie for Prize Essay in the Northern Command).—By Major W. Ewbank, R.E.

3. LINE OF COMMUNICATION TRANSPORT.—By Capt. F. W. Hawks, S. & T. Corps.

4. MOUNTED INFANTRY TACTICS IN HILL AND DENSELY-WOODED COUNTRY (Second Essay in the Burma Division).—By Lieut.-Colonel H. D. U. Keary, D.S.O., 91st Punjabis.

5. INFANTRY SCOUTING.—By Major A. T. Spearman, Royal Warwickshire Regiment.

All these articles are too long for justice to be done in a brief notice. As to the first, however, it is worthy of record that the author's idea of an Army Headquarters to suit this country is



His object is "to divorce strategical policy from administrative execution, lest policy should be bent to evade executive difficulties; and to make finance subservient to administration, lest efficiency should be marred in its struggle with economy."

Minds, men, materials, and money are the four elements of the matter; and a division of the headquarter administration into four great departments to correspond therewith would appear to be the most economical system. It will be observed that the author combines the three last ms under a Chief of the Administration.

A. T. MOORE.

NATURE.

December, 1905.

CANADIAN ELECTRIC POWER STATIONS AT NIAGARA (*p.* 161).—The great power house is situated in Victoria Park on the Canadian side at Niagara. The Canadian Company is allied to the Niagara Falls Power

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Company of the New York side of the river, but in its Canadian development it has given men of science the most wonderful installation to study yet known in the field of any water-power development. On the New York side the unit of development is 5,000 horse-power, but on the Canadian side the unit is 10,000 horse-power. In the wheel-pit and tunnel method of developing power at Niagara, a great slot, several hundred feet long, 180 feet deep and 21 feet wide, is excavated in the earth. From the bottom of the wheel-pit a tail race or tunnel is driven through solid rock, a distance of 2,200 feet, to the lower river. This tunnel is in the form of a horseshoe, 20 feet wide and 25 feet high, lined from end to end with vitrified brick and concrete, while the wheel-pit is also carefully lined. From the upper river a short canal diverts water from the main stream to a forebay at one side of the big power house. Near the bottom of the wheel-pit the turbines are installed, connected to the generators in the power station over the wheel-pit by vertical shafts. From the forebay penstocks, 10 feet in diameter, run to the turbines, and as the gates are raised the water pours from these penstocks into the wheels that give motion and life to the big generators, which make 250 revolutions a minute, the speed at which they are steadily worked. The water leaving the turbines falls into the tunnel and then flows through the tail race to the lower river and gorge. All power generated in Victoria Park must be, by agreement, transmitted outside the Park limits for application and use. It will therefore have its voltage raised at a transformer station to 40,000 or 60,000 volts, in order that it may be sent economically to Toronto (90 miles away) and other distant places to meet the demand for electric power for trolley cars, lighting, etc.

THE PANAMA CANAL (*p.* 199).—The United States Government referred the technical question, as to whether the canal should be a sea-level one or one constructed with locks, to an International Engineering Advisory Board which recently visited the site. The Board has by a majority of three recommended the construction of a sea-level canal. This project consists of a canal with a bottom width of 150 feet, a minimum depth of water of 35 feet, and twin tidal locks at Miraflores (on the Pacific side), having an available length of 1,000 feet and a width of 100 feet. It is estimated that this canal can be completed in ten years at a cost of 230,500,000 dollars, the Chargres River being controlled by a dam at Gamboa (midway between the oceans), forming a lake from which the surplus waters would be discharged by a tunnel through the dividing ridge into another river basin. A canal with locks having a summit water level 30 feet above mean sea level would have cost 194,000,000 dollars; but the Board considered that a sea-level canal free from the restriction of locks, and which could be easily enlarged and deepened to accommodate an increased traffic and larger vessels, would be well worth the additional cost.

EXPERIMENTS WITH EXPLOSIVES (*p.* 194).—The researches carried out in the laboratory of the Carbonite Explosives Company, Hamburgh, are given to English readers in a valuable little volume published by

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Griffin & Co. The experiments have been made with quantities as nearly as possible approaching those employed in actual practice, so that for some explosives we now have details obtained from experiment on a much larger scale than any hitherto adopted, *e.g.*, for gunpowder 1,500 grams and for the higher explosives 300 grams were exploded. In connection with the safety of explosives for mining, the length of the flame, its duration and temperature, are of the greatest importance. The two former were recorded photographically, a quartz lens being used. A factor deduced from the ratio of the flame duration to the detonators time, termed the "after-flame ratio," is shown to have great influence on the ignition of fire-damp. The general bearing of the book on the question of safety is clearly dealt with, and tables give a mass of information relating to the explosives examined.

THE HEAD HUNTERS OF BORNEO.—By Mrs. Cator.—The authoress states that "there is nothing revolting in their head hunting, they fight fairly." It is their chance of winning renown and showing what they are made of. A woman's head, owing to her longer hair, is prized more highly than that of a man, but the whole thing to them is a thrilling game, full of excitement* and danger. There is nothing unfair in their warfare, both sides are doing the same, and man after man wins his spurs in feats of pluck and daring. When not thus engaged, the authoress describes them as being gentle and extraordinarily peaceful in their home life, so much so that she had never heard of a "family jar."

W. E. WARRAND.

ORGAN DER MILITÄRWISSENSCHAFTLICHEN VEREINE.

Vol. 3. 1905.

THE AUSTRIAN RAILWAY AND TELEGRAPH REGIMENT.—This article gives an account of the working of the Hungarian state railways during the strikes in April, 1904. The strikers numbered 37,000, and the railways affected by the strike had a total length of 13,000 kilomètres.

On the 22nd April 129 men of the Railway Regiment arrived in Budapest to take over the working of the railways. They were reinforced by reservists from the 7th Pioneer Battalion and 32nd Infantry Regiment, to the number of 151 men.

Many of the smaller parts of the engines had been removed or broken by the strikers, who had also taken away the telegraph instruments. The men of the Railway Regiment were unfamiliar with the type of engine in use on the State railways and with the mechanism of the Westinghouse brake.

In spite of these and many other difficulties three trains were despatched from Budapest on the 22nd April. These reached their

* More so than our Rugby football.

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destinations in safety, though obstacles had been placed across the rails at various places and the points wedged with stones. During the night of the 22nd six more companies of the Railway Regiment, numbering 24 officers and 438 men, arrived in Budapest. The next day eleven trains were despatched, and the day after thirteen.

On the 25th April the majority of the strikers returned to work, and on the 4th May the Railway Regiment was entirely withdrawn from the State railways.

The experience gained revealed the necessity for more technical knowledge on the part of the officers; there was also a dearth of experienced engine drivers among the men.

J. E. E. CRASTER.

REVUE D'HISTOIRE.

November, 1905.

CAMPAIGN OF 1794.—*Army of the North.*—On April 16th the Emperor Francis reviewed the allied main army, numbering 75,000 men, at Cateau. Next day operations were begun for the investment of Landrecies. The movements of the several columns are fully described.

THE BENAVENTE RACE.—This is an extract from a forthcoming volume of Commandant Balagny's history of Napoleon's campaign in Spain. The hurried march from Madrid to Astorga in the hope of intercepting Moore was known in the French army as 'the Benavente race.' Of the cavalry action at Benavente, in which the chasseurs of the Guard were routed, the writer says:—

"Why did the French horsemen twice remain at the halt when the enemy charged them? So vicious a practice can only be explained by the contempt for the enemy which a long series of successes had inspired in our soldiers, or by the wish to break his ranks by point-blank fire before assailing him sword in hand; anyhow we meet with many examples of it in the wars of the Empire, and strange to say the method was often successful, especially against Spaniards and Austrians; but it never answered with the English, who always charged home on very hard-mouthed horses."

THE WAR OF 1870-1871.—*The Army of Chalons.*—On August 26th Macmahon's army crossed the Aisne on its way to Montmédy. The German armies began to move northward and the 12th German Corps came within 15 miles of the 7th French Corps. Macmahon offered large rewards for news of Bazaine, and wrote to him that in the absence of such news he could hardly advance further eastward.

December, 1905.

CAMPAIGN OF 1794.—*Army of the North.*—Completion of the investment of Landrecies. This was skilfully executed, but "the tactical advantages so

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obtained were soon nullified by the vicious strategy," which gave Pichegru the opportunity of operating against both flanks of the Allies.

THE BENAVENTE RACE (*concluded*).—The success of the French cavalry at Mansilla, where it routed 4,000 Spanish infantry, is contrasted with its failure at Benavente. The reasons that led Napoleon to turn back at Astorga, and leave the pursuit of the English to Soult, are fully discussed. His own statement on the subject at St. Helena is shown to be substantially true, viz., that it was the news of Austrian preparations and of intrigues at Paris.

WAR OF 1870–1871.—*The Army of Chalons.*—On August 27th the 1st, 5th, and 12th Corps (French) moved south-eastward to support the 7th, which seemed to be threatened, and there was a cavalry encounter at Buzancy. In the evening Macmahon decided to retreat on Mézières. He issued orders accordingly, and informed the Minister of War of his intention. The minister replied in the course of the night: "If you abandon Bazaine there will be revolution in Paris, and you will be attacked yourself by all the forces of the enemy." He urged Macmahon to persist in his advance on Metz, and assured him that he had 36 or 48 hours' start of the enemy. The marshal, thereupon, cancelled the orders he had issued. "Having taken this decision I sent an aide-de-camp to the Emperor to inform him of it. Soon afterwards General Pajol came to tell me on behalf of His Majesty that he regretted this last order. I replied that I had maturely considered the matter, and that it was impossible for me to countermand the orders which I had just given. This was the only time throughout the campaign that the Emperor made any remarks to me about the course of the operations." (*Unpublished Reminiscences of Marshal Macmahon*).

E. M. LLOYD.

REVUE MILITAIRE DES ARMÉES ÉTRANGÈRES.

October, 1905.

A GERMAN COLONIAL CAMPAIGN (*Operations against the Hereros*).—This article is of sufficient interest to justify a lengthy summary of its contents. It gives a detailed account of the methods which Germany adopted in coping with a situation that has often confronted us, but with which she was entirely unfamiliar.

Her lack of success was primarily due to the fact that, with the exception of a composite battalion of marine infantry (numbering 500 men), she had no troops immediately available for service abroad. Much valuable time was therefore spent in raising and training successive contingents of mounted infantry and artillery; and even when these were fit to take the field, they were still distinctly inferior in mobility to the Hereros, though the latter moved with their families and cattle.

The German columns had an unusually large proportion of artillery—roughly two batteries to three companies of mounted infantry; and it is

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difficult to believe that so many guns were necessary, especially as the Hereros had no artillery at all. Probably the artillery could have been dispensed with altogether, and had this been done the columns would have been rendered more mobile. As the Hereros were entirely dependent on their cattle, it seems that the Germans should have made the cattle their objective from the first.

Since the end of 1903, Germany has been engaged in suppressing, or attempting to suppress, a rising of the native tribes in South-West Africa. The cost of the military operations, both in men and money, has been so great that many Germans are doubtful whether the country is worth the expenditure.

The area of South-West Africa is one and a-half times that of Germany. There are no good harbours on the coast, and only two inferior roadsteads, one at Swakopmund and the other at Luderitzbucht.

The land rises from the coast in terraces to a region of high plateaus, which stretches eastward for about 500 kilomètres as far as the Kalahari Desert. The plateaus are the most healthy and populous part of the country. The northern plateaus are comparatively low, less than 3,300 feet, and are covered with tropical vegetation; they are inhabited by the Ovambos, an independent tribe of Bantu origin, who cultivate the soil and practice various native industries.

South of the 20th parallel the country is more rugged and mountainous, the highest peak is over 7,000 feet and the plateaus vary in height from 4,000 to 5,300 feet. High thick bush occurs in places, and there is plenty of grass. This region is inhabited by the Hereros, a pastoral tribe of Bantu origin, who came from the north and conquered the country at the end of the 18th century.

South of the 23rd parallel the country becomes gradually drier, bare and rocky hills alternate with sandy plains, and the bush gives way to desert. It is sparsely inhabited by Hottentot tribes, whose miserable cattle form their only means of subsistence.

From the port of Swakopmund to Windhuk (382 kilomètres) there is a light railway, but the gauge is only ·6 mètres (less than 2 feet). There is also another railway under construction from Swakopmund to Otawi. The disembarkation of troops and horses was a very tedious process, owing to the fact that steamers cannot come alongside the pier at Swakopmund.

Before 1896 there had been many native risings in the German Colony; but by employing the Hottentots against the Hereros, and *vice versâ*, they were always successfully repressed. In 1896 the whole country was pacified by the lenient measures introduced by the governor, Colonel Leutwein. From 1896 to 1903 the tribes remained quiet, and the Germans appeared to have been lulled into a false sense of security.

In October, 1903, the Bondelzwarts, a Hottentot tribe occupying the extreme south of the colony, revolted. At this time there were only four companies of German troops, a mountain battery, and a few native police in the colony. By the beginning of December the rebels had been defeated and dispersed by a company from Keetmanshoop and a detachment of Witbois.

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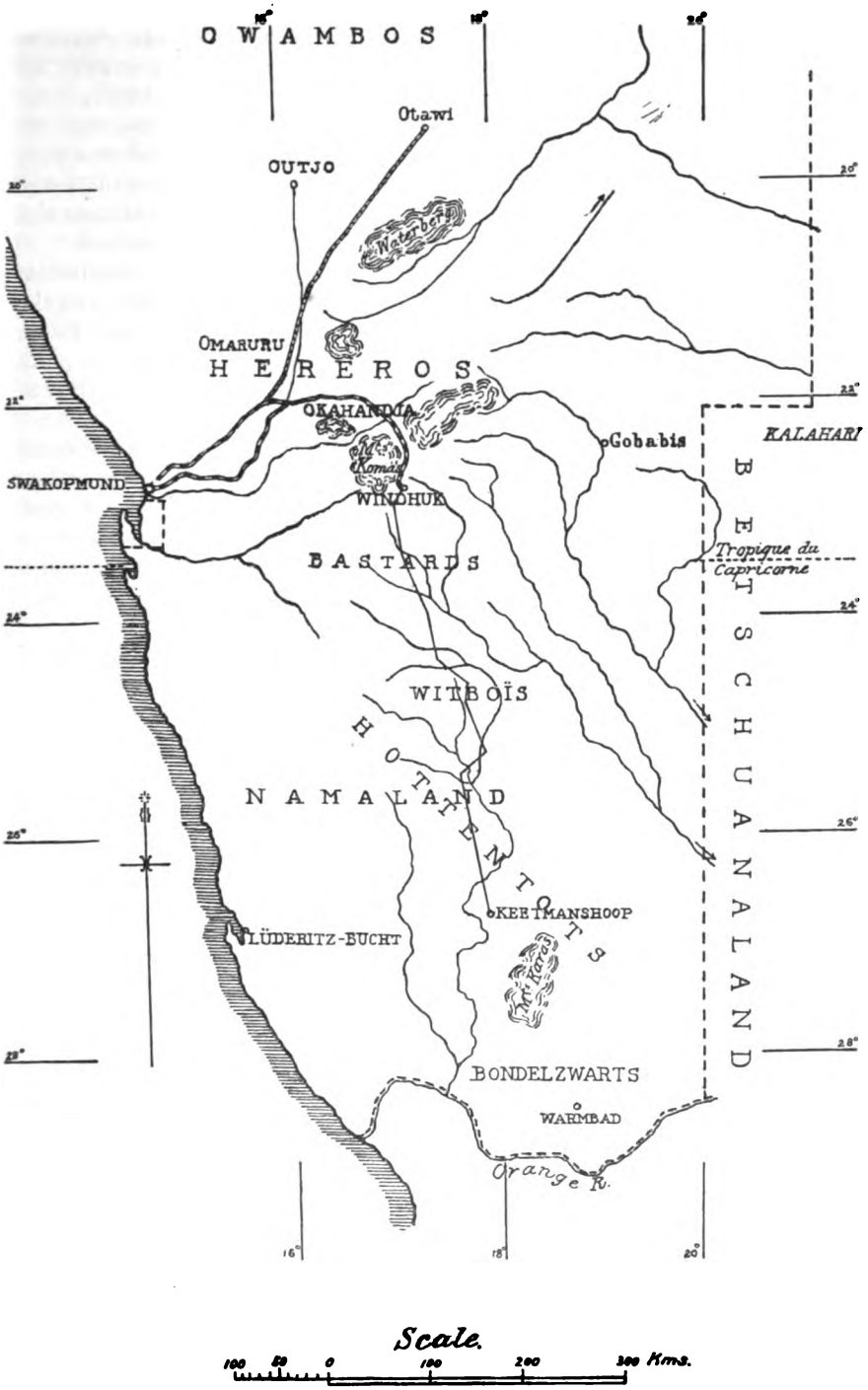
SKETCH MAP OF GERMAN S.W.AFRICA



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The governor, Colonel Leutwein, did not receive news of this success until some time later, and meanwhile despatched two more companies to assist in repressing the rebellion. With the exception of a company at Outjo, the northern and central portions of the colony were therefore quite denuded of troops. This gave the Hereros the opportunity for which they had been waiting; they rose on the 12th January, 1904, attacked isolated farms and massacred the inhabitants, and cut the railway and telegraph on both sides of Okahandja. The Hereros were able to muster a force of about 6,000 men out of a total population of 60,000 to 80,000; they were good shots, and were armed with Mauser and Lee-Enfield rifles, for which they had ample supplies of ammunition.

Luckily, all the Germans capable of bearing arms, to the number of about 500, had been called out before the rising, and had reinforced the small garrisons in their own districts. A detachment under Lieut. Boysen, sent from Windhuk to relieve Okahandja, was cut to pieces; but Lieut. von Zülow, with about 100 men from Swakopmund, was able to reach the place and reinforce the garrison.

By the end of January a company, recalled from the south of the colony, had relieved Windhuk, Okahandja, and Omaruru; but the company at Outjo was still cut off, Gobabis was besieged, and the Hereros were gathering again in the Kamas mountains. The first reinforcements to arrive were the reliefs for the colonial troops, numbering 226 officers and men; they reached Swakopmund in February, and were at once despatched to Windhuk.

On the 17th January an order was issued in Germany for the formation of a composite battalion, of four companies of 125 men each, from the two marine infantry battalions at Kiel and Wilhelmshaven. There were no other troops available for service abroad, so it was necessary to call for volunteers from all branches of the army to form a special corps for the purpose.

The bulk of the force was equipped as mounted infantry. These were despatched in haste to South-West Africa under officers who had for the most part no experience of foreign service; it was not, therefore, until after their arrival at the latter port that anything could be done to train or organize this very heterogeneous collection of men and animals. This caused much delay; one detachment, for instance, was not ready to take the field until 38 days after disembarkation.

Colonel Leutwein a little later wrote as follows:—"A number of men belonging to all arms and a number of unbroken horses are not all that is required to form a company of battery fit to take the field. The infantry cannot ride and the cavalry cannot shoot."

To add to the confusion they had pom-poms, mountain guns, field guns, and maxims of various patterns; lastly, the operations were to be conducted by two officers of equal rank, one the commander of the expeditionary force, and the other the governor of the colony.

The first detachment under Major von Glasenapp reached Swakopmund on the 9th February. Various small columns were formed and despatched in different directions, but for the most part failed to get in touch with the enemy. However, a column, consisting of 120 mounted men

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with 3 field guns and a pom-pom, came up with a force of about 1,000 Hereros, whom they defeated after ten hours fighting, capturing 2,000 head of cattle.

By the 10th March the forces in the colony amounted to 2,500 men; the railway communication had been restored, and the various sieges raised; but the Hereros were still at large. Colonel Leutwein found that the forces at his disposal were not sufficient to enable him to pursue the enemy, and therefore asked for further reinforcements, amounting to 800 men and two batteries.

In spite of Socialist opposition, the Reichstag voted a further sum of six million marks, in addition to 2,821,000 already sanctioned, and at the beginning of April a force, consisting of 1,100 men, 1,200 horses, and 12 guns, was despatched.

Meanwhile a column, consisting of 11 officers and 55 mounted men under the command of Major von Glasenapp, was ambushed by the Hereros, only one officer and thirteen men escaping unwounded. During the first week of April Colonel Leutwein attempted to attack a force of 3,000 to 4,000 Hereros with two independent columns approaching from opposite sides. The main column, however, was not ready to start on the date fixed. Consequently the Hereros were able to surprise the smaller column, commanded by Major von Glasenapp, while it was entangled in thick bush; it lost heavily and was compelled to abandon its objective. Between the 13th March and the 3rd April, Major von Glasenapp's force had lost 63 per cent. of its officers and 39 per cent. of its men, out of a total strength of 14 and 476 respectively. It was unable to take the offensive again.

On the 9th April Colonel Leutwein's column came on a force of about 3,000 Hereros occupying a position 5 or 6 kilomètres in length. After nine hours fighting the Hereros were defeated, and the Germans captured a few cattle. It was not till four days later that Colonel Leutwein set out with the greater part of his force in pursuit of the enemy's main body. While the column was marching through the bush it was surprised, and only got clear after six hours fighting; it was compelled to retreat during the night. Colonel Leutwein therefore decided that more reinforcements were necessary.

Though many people in Germany had already pointed out the folly of sending out reinforcements in driblets, yet, for fear of provoking the opposition of the Reichstag, this was the policy adopted. General Trotha was now appointed to the sole command of the troops in South-West Africa, and Colonel Leutwein's authority was restricted to the civil administration. It was further decided to organize a regular expeditionary force with a proper staff. The force consisted of a mixed brigade of 19 companies of mounted infantry, 7 four-gun batteries, and two maxim detachments, besides various units for the lines of communication. Yet when General Trotha reached South-West Africa, he decided that even this force was not sufficient, and asked for four more companies and two new batteries.

The difficulty of disembarking the troops at Swakopmund rendered it necessary to send out the transports at long intervals, but by the beginning

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of August General Trotha had received all the troops he required. The Hereros had been located on the southern slopes of the Waterburg, and General Trotha decided to surround them there. For this purpose he divided his force into five columns, which were to attack from opposite sides, the passes over the hills being held by a sixth force. On the 11th August the Hereros resisted the advance of four of the columns, and handled one so severely that it was compelled to retreat during the night, leaving a gap in the cordon through which the Hereros escaped to the south-east. They were able to take with them the majority of their women, children, and cattle. The Germans lost 12 officers and 69 men.

This was the last engagement of any importance. The Hereros were gradually driven eastward into the desert, where many perished of famine. Some finally crossed the frontier and were disarmed in British territory; others surrendered to the Germans; but many succeeded in getting back to the interior of the colony.

On the 18th October, 1904, the Witbois, a Hottentot tribe who had hitherto helped the Germans, revolted. The operations against them will form the subject of another article in the *Revue Militaire*.

The reinforcements that Germany has despatched since the beginning of the disturbances amount to 15,734 men and 13,000 horses. The Hottentots are still (October, 1905) unconquered, and it seems probable that an expedition against the Ovambos will be necessary before long.

J. E. E. CRASTER.

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CORRESPONDENCE.

THE PREVENTION OF DAMPNESS DUE TO CONDENSATION IN MAGAZINES.

DEAR SIR,

The letter from Capt. H. J. Walker, R.E., in the December number of the *R.E. Journal* would give one the impression that hollow walls and revolving-cowl ventilators form a perfect cure for dampness in magazines.

These expedients have been for years embodied in the type plans issued by the War Office for the guidance of those who have to design or build batteries; but magazines built in accordance with these type plans are still damp, often very damp.

The "hollow wall" so called (which denotes a $4\frac{1}{2}$" brick wall separated by from 2" to 4" from the concrete that forms the main wall) is undoubtedly beneficial; but it is doubtful whether the revolving-cowl ventilator does not do more harm than good.

If the ventilator draws in hot damp air, this is bound to condense on the walls of the magazine.

From my experience there are only two cures for a damp magazine;—*i.e.* sunlight, or heating by hot-water pipes.

To arrange for sunlight to reach the greater part of the magazine in a modern 12-pr. Q.F., 4·7" B.L., 6" B.L., or 9·2" B.L. coast battery is not so difficult as might be imagined; for store magazines the only remedy is artificial heat up to the temperature of the air outside.

It would be well, perhaps, to give reasons in detail for the above conclusions; and to say that the experience alluded to was gained in carrying out both new work and reconstruction for batteries containing all the types of ordnance enumerated.

All these batteries were constructed in accordance with the latest method for preventing dampness; and by comparing those 6" B.L. battery magazines which were damp with others that were dry I came to the conclusions given above.

Reconstruction work confirmed these conclusions. For example I may say that at Fort McNab there were, during the first years I was at the station, constant complaints by the Artillery of the dampness of all the underground buildings, not so much because of the damage done to the cordite which was stored in air-tight cases, but because it was impossible to keep from rusting the bright spare parts of the guns in the R.A. Store. During the summer the whole of the underground buildings ran with water, as if a spring of water had broken into them through

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a crack in the concrete walls. For years the spare parts of the guns were moved in the summer into a wooden building.

It appeared curious at first that these buildings were quite dry in winter, when the temperature was seldom above the freezing point; but when it was recognized that the dampness was due to condensation, this was easily explained.

Later on, the turn came for revising this battery (which carried B.L. guns, but not of a modern type); and during the early summer the rear walls of the magazines were uncovered, and a hole broken through each. Directly the sunlight entered the walls became bone-dry.

As a further confirmation York Redoubt may be mentioned. Here were shell stores and cartridge stores of great variety of construction, perhaps 20 altogether, some with plain concrete walls, some with a brick lining, and some with "hollow walls." Of these, the brick lining showed an improvement on the solid concrete, the "hollow wall" showed an improvement on the brick lining, but the only dry shell or cartridge stores were those to which sunlight was admitted.

As said before it is not difficult to arrange for the admission of sunlight to a modern coast-battery. The very latest type plan of 6″ B.L. battery shows plenty of window space; but the area should be extended (even if some additional cost be implied) so that light may be thrown on the shell lifts and cartridge lifts (the iron work of which is most difficult to keep from rusting in the damp and darkness).

I may add that in batteries generally, wherever windows are required to admit light only (and not to give a view of the outside to persons inside), "translucent fabric" is preferable to glass, as there are no breakages after gun firing. "Translucent fabric" consists of a wire screen embedded in a gelatinous substance. It is proof against stone-throwing and rough handling generally.

Yours truly,

T. E. NAISH,

Major, R.E.

The Editor, "R.E. Journal."

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Prepare Candidates for the Navy and all Army and Civil Service Examinations at

5 & 7, LEXHAM GARDENS, KENSINGTON, W.

We have retained the services of all the Tutors who have been so remarkably successful in past years, and continue to receive both resident and non-resident candidates.

Recent Successes Include:—

STAFF COLLEGE, AUGUST, 1905.

ON THE COMPETITIVE LIST.

Capt. E. B. Ashmore.....Royal Horse Arty.
,, W. H. F. Weber*...Royal Horse Arty.
,, H. A. Boyce*.....Royal Field Arty.
,, A. A. Montgomery...Royal Field Arty.
,, F. W. Brunner.....Royal Engineers.
,, W. Robertson .....Royal Engineers.
Bt.-Major B. T. Buckley...Northumberland Fusiliers.
Capt. G. D. Jebb, D.S.O. Bedfordshire Regt.
,, J. W. O'Dowda... R. West Kent Regt.
,, J. H. Davidson, D.S.O. King's Royal Rifle Corps.
,, R. J. Drake.....North Staffordshire Regiment.
,, H. E. M. Hutchinson West India Regt.
,, E. F. Orton.....Indian Army.

THE FOLLOWING RECEIVED NOMINATIONS.

Bt.-Maj. T. A. Cubitt, D.S.O. Royal Field Arty.
Capt. M. G. E. Bowman-Manifold, D.S.O..... Royal Engineers.
,, W. E. M. Tyndall, D.S.O.....West Riding Regt.
Capt. G. J. Farmar.....Lancashire Fus.
,, R. F. Riley, D.S.O...Yorkshire Lt. Infy.
,, C. C. Newnham....Indian Army.

*Read partly at the Army College, Aldershot.

August, 1904.

SEVENTEEN passed on the Competitive List and THREE received Nominations.

August, 1903.

TWELVE passed in the Competitive List and FIVE received Nominations.

August, 1902.

ELEVEN passed in the Competitive List and FIVE received Nominations.

PROMOTION.

More than EIGHTY OFFICERS who Read with us PASSED (d) in May last.

WOOLWICH, JULY, 1905.

THE FOLLOWING PASSED DIRECT FROM US:—

SECOND	A. E. H. KILLICK	... ...	12,519
22nd	L. C. OWEN	... ...	11,335
29th	G. E. A. GRANET	... ...	11,280

Mr. Killick put on 3,320 marks since joining our classes in January last.

Places taken include French, SECOND, Eighth; Latin, FIRST; Greek, SECOND; German, Third, etc.

SANDHURST, JULY, 1905.

THE FOLLOWING NINE PASSED DIRECT FROM US:—

SECOND	J. A. CHURCHILL	10,230	29th	H. E. W. BERKELEY-HILL	8,865
FIFTH	J. D. DARLING	9,735	122nd	J. G. CRAUFURD	7,814
10th	H. L. WHEATLEY	9,603	138th	N. S. REGNART	7,740
13th	H. G. L. HALL	9,491	196th	W. H. BROOKE	7,190
24th	W. T. H. GREGG	8,978			

And Four others obtained qualifying marks.

Places taken include Mathematics (i.) FIRST, Mathematics (ii.), SECOND; French, SECOND, Fourth and Fifth; German, SECOND; Latin, SECOND; Chemistry, FIRST.

SPECIAL ARRANGEMENTS HAVE BEEN MADE FOR THE ARMY QUALIFYING EXAMINATION IN MARCH NEXT.

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U. C. L. DUPLICATE

THE ROYAL ENGINEERS JOURNAL.

Vol. III. No. 3. MARCH, 1906.

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MILITARY COLLEGE, RICHMOND, SURREY.

(Inspected by the University of London).

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SUCCESSES JANUARY, 1904, TO JANUARY, 1906.

WOOLWICH.

Place.	Name.	Place.	Name
8th	C. Holland.	43rd	S. M. Noakes.
*15th	H. Smithson.	46th	V. A. H. Taylor.
18th	C. H. Lemmon.	50th	H. G. Worsley.
*19th	W. E. Buckingham.	*56th	B. F. Rhodes.

SANDHURST.

6th	G. H. MacCaw.	32nd	A. E. Saunderson.
11th	A. G. Saulez.	39th	H. A. Studdy.
*15th	G. I. Carmichael.	66th	H. K. D. Evans.
23rd	R. H. Koster.	131st	R. G. Moody-Ward.
*25th	H. F. Slattery.	148th	G. T. Wright.
30th	J. S. Hicks.	151st	D. M. King.

K.I.C. ..... A. F. Prendergast.

INDIAN POLICE.

2nd ... ... W. T. Wickham.

ARMY QUALIFYING CERTIFICATES.

ROYAL ARTILLERY.

Name.	Regiment.
F. G. J. Berkeley	The Yorkshire R.G.A.
A. F. A. Hooper	The Duke of Edinburgh's R.G.A.
G. B. Bosanquet	3rd Bn. The Suffolk Regt.
E. L. Salier	4th Bn. Shropshire Light Infantry.
C. K. Apthorpe	4th Bn. South Wales Borderers.

CAVALRY OR INFANTRY.

W. C. Wilson	6th Bn. Royal Warwickshire Regt.
K. P. Wallis	Royal Monmouthshire R.E.
G. F. Bowes-Lyon	4th Bn. Argyll and Sutherland Highlanders.
G. H. Westbury	4th Bn. Royal Berkshire Regt.
E. S. Bamford	3rd Bn. Leicestershire Regt.
G. M. Wright	3rd Bn. Royal Munster Fusiliers.
T. H. O. Crawley	7th Bn. Royal Fusiliers.
W. F. Anderson	7th Bn. Royal Fusiliers.
L. F. Hepworth	4th Bn. East Surrey Regt.
W. Grischotti	S.E. of Scotland R.G.A.
S. O. Robinson	5th Bn. Middlesex Regt.
E. F. Robinson	3rd Bn. Shropshire Light Infantry.
*H. H. Clarke	3rd Bn. Royal Welsh Fusiliers.

*Successful under the New Army Regulations.

MILITIA COMPETITIVE.

Place.	Name.
3rd University	G. K. Archibald.
4th University	H. Wilson.
6th Infantry	G. F. Bowes-Lyon.
12th Infantry	J. Mallingson.
13th Infantry	C. K. Apthorpe.
18th Infantry	S. H. Drummond.
39th Infantry	L. F. Hepworth.
49th Infantry	W. Grischotti.
51st Infantry	J. T. Hibbert.
59th Infantry	T. E. V. Forster.
W.I.R.	C. F. Hughes.
W.I.R.	F. J. Stevens.

PROMOTION.

Over ONE HUNDRED and FIFTY OFFICERS passed in "C" and "D."

STAFF COLLEGE, AUGUST, 1905.

EIGHT Officers were prepared—ONE received a nomination, and SEVEN qualified.

N.B.—Special Terms for Sons of Officers of the Royal Engineers.

Telegrams—Trippel, Richmond, Surrey. Telephones—72 and 341 P.O. Richmond, and 884 Mayfair.

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Contributions should be written *on one side only of the paper*, and preferably on white paper of foolscap or bank post size.

Each article must be accompanied by the name of the author, but the question of publishing it over his signature or under a pseudonym is left to his discretion.

Authors are allowed six re-prints of accepted contributions, provided a request to this effect is forwarded with the manuscript.

Manuscripts, whether accepted or otherwise, will not be sent back to contributors unless their return is specially asked for at time of submission.

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BARR AND STROUD RANGEFINDER, F.Q. TYPE, "INFANTRY," 1 METRE BASE, FOR USE WITH INFANTRY, CAVALRY, AND MACHINE GUNS.

This Rangefinder is constructed largely of Aluminium and is covered externally with brown leather. It is fitted with pads on the ends to prevent damage by rough handling. It is supplied in a strong leather case, as shown, fitted with a shoulder-strap.

The tripod shown in the illustration is not supplied with the instrument, as the Rangefinder is so constructed that it can be used with ease without a stand.

Approximate uncertainty of observation: –

1 yard at 400 yards.
5 yards at 1,000 yards.
40 yards at 3,000 yards.

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1. Ligh

2. Bows

3. Trestle Bridge to carry 3' 6" Railway.

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SOME IDEAS ON FIELD WORKS.

THE following extracts from the reports on the Annual Courses of several Companies are published as being worthy of general study.

1. REDOUBT CONSTRUCTED BY THE 17TH (FIELD) CO., R.E.

The chief point is the reduction of the loophole to the smallest possible dimensions (*Fig.* 1 of *Plate* I. at end).

The loopholes were made continuous, 3 inches high in the clear. They had to be made so as to fire down a slope of $\frac{1}{7}$ and also at extreme elevation on to a hill about 3,000 yards distant. To effect the latter a second arm rest was constructed below and behind the normal one. The method of firing is shewn in *Figs.* 2*a* and 2*b*).

The view from the loopholes is as good as from the parapet.

The profile of the redoubt was very low, and long grass was planted just in front to break up the straight line of the loopholes. It was, however, found impossible to entirely hide this line, so very shallow trenches were dug on the face of the hill, parallel to the loopholes and at varying intervals. It was then impossible to distinguish the loophole line from these trenches from any distance, and the trenches were not deep enough to afford any cover.

Another point of interest is the addition of a few inches of shingle on the crest of the parapet to prevent bullets penetrating into the loophole.

2. A LIGHT SUSPENSION BRIDGE, TO CARRY INFANTRY AT 4 PACES DISTANCE, MADE BY 29TH (FORTRESS) CO., R.E.

Photo 1 gives a good general view of the bridge, the span of which was 132 feet and the final dip $\frac{1}{15}$.

The material used consisted of galvanized iron wire, breaking strain 1,000 lbs. per square inch, $6'' \times 6''$ deals for the end frames, $4'' \times 2''$ planking for the intermediate frames, $\frac{1}{2}''$ iron bolts.

The suspending cables were 12 in number, and each consisted of 2 wires seized at every 15 feet with No. 20 wire. The cables were made fast to the anchorages by a round turn and fishplate clips. At one anchorage it was found possible to grip all 12 cables with one fishplate, using 4 bolts. At the other, to facilitate the adjustment of the cables, they were gripped in pairs by half fishplates.

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The end frames were strutted and guyed to the anchorages, which were of the usual type of buried log. The 12 intermediate frames were made up as shown in *Fig.* 3.

The roadway consisted of 12″ × 2″ planking.

The bridge was got out by fixing all the cables at one anchorage and threading all the frames on to them near the other anchorage. The cables were then temporarily adjusted and clipped and the frames and roadway boomed out. The cables were finally adjusted, and a single-wire catenary was stretched on either side to prevent horizontal swaying.

In making the anchorage, it was found important to give plenty of room to work in, as otherwise, with so many small cables, much time is wasted.

3. SWINGING DERRICK ON BARREL RAFT, USED BY 1ST FIELD TROOP, R.E.

This was found very useful in placing the trestles of a bridge, particularly a four-legged trestle.

The raft was formed of 29 barrels, 108 gallon, arranged as shewn in *Fig.* 4.

The butt of the derrick spar rested on the centre of a wheel, which was firmly lashed to the tie baulks of the raft. An oak dowel was made to fit into the axle hole, being shouldered to prevent it dropping through, and long enough to stand up 3 inches above the nave of the wheel. The foot of the spar was morticed out to take this dowel, and was bound round with wire at the base to prevent splitting.

4. BOWSTRING GIRDER BRIDGE, TO CARRY INFANTRY CROWDED, ERECTED BY THE 29TH (FORTRESS) CO., R.E.

Photo 2 and *Fig.* 1, *Plate* II., show the bridge in detail.

The top boom was built up of five 10″ × 1″ planks bolted together, and the bottom boom consisted of 10″ × 5″ beams.

The girders were made in the bottom of the gap; and were raised, one end at a time, by means of a derrick.

5. FLYING TRENCH WORK AT NIGHT, BY 43RD (FORTRESS) CO., R.E.

An improved method of constructing flying trench work at night consisted in the use of hurdles (6′ long, 3′ high) instead of gabions.

Each 2 men were provided with 2 hurdles, 1 pick, 1 shovel, and 3 loops of wire (2′ long). On arriving at the site of the trench, the hurdles were driven in, 2′ apart, and the wire loops placed over the tops of the hurdles at the centre and ends.

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The two men dug out enough earth to fill the 6′ run of parapet between their two hurdles, the trench being roughly 18″ deep, with a berm of 12″.

On a very dark night, 40 men executed 40 yards of this parapet in 1¼ hours.

6. PILE BRIDGES.

The 2/41st (Fortress) Co., R.E., erected a simple pattern pile bridge.

Such bridges appear to have been much used by the Japanese in the late war, and might profitably be practised by R.E. Companies whenever possible.

7. RAILWAY TRESTLE BRIDGE, CONSTRUCTED BY BRIDGING COMPANIES, R.E.

In July, 1904, and July, 1905, a railway trestle bridge was constructed by the 1st, 2nd, and 3rd Bridging Companies, Royal Engineers, as part of their annual training, over a gap near Curzon Bridges, about 1 mile from Pirbright Camp (*Photo* 3 and *Figs.* 3 and 4). It was designed to carry a 3′ 6″ railway, and was made in four tiers, viz., 3 tiers of wooden trestles resting on a bottom tier of pile piers driven 5′ deep into the ground. Each of the 4 tiers was 10′ high, so that the bridge was 40′ high at the highest part; the bays were 11′ 6″, and the span was 334′. The timber was all felled at the back of the Ash Ranges, whence it was transported to the site of the bridge, distant 2¼ miles.

The first two tiers were erected in July, 1904, and the bridge completed and line laid the following July.

The average daily number of non-commissioned officers and men employed on the bridge was 120, including 4 smiths and 22 wheelers and carpenters. The hours of work were 6.0 to 7.45 a.m., 9.0 a.m. to 12.45 p.m., and 2.0 to 4.0 p.m., total 7½ hours. The number of working days occupied in construction, including the cutting and carrying of half the timber required, was 27½ days.

Trestles consisted of standards, capsills, groundsills, and side struts. Standards were trenailled with oak trenails into capsills and groundsills. Side struts were dogged to capsills and groundsills; to economize iron and facilitate dismantlement only 8 dogs were used per trestle.

The method of construction was as follows:—The whole of the piers of the bottom tier were driven, and a capsill fixed on the top of each. Longitudinal stringers were then spiked down to these, placed so as to come immediately below the legs of the trestles of the next tier. The trestles of the second tier had meanwhile been made, and were then placed into position, those in the centre being lifted by derricks, and those at the ends of the bridge being slid out and then lifted upright by derricks. Stringers were again fixed as for the first tier, and

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then the 3rd and 4th tiers placed in a similar manner. The bridge was further braced longitudinally by the addition of timbers spiked diagonally to the legs of each trestle.

The trestles near the centre of the bridge were hoisted into position by 50′ derricks and 5″ rope tackles (the spars for these derricks had been brought out from Aldershot); to prevent distortion during raising, the capsills and groundsills were held to the standards by two rope slings placed right round the trestle and windlassed up until taut.

The piles were all driven by hand monkeys, of oak clamped with iron, weighing about 120 lbs., made by the Bridging Companies. The best arrangement for preventing the handles shaking loose from the monkeys is to have the 4 handles fixed to two iron collars which encircle the monkey a few inches from either end and are clamped by screw bolts; additional iron collars are necessary at each end of the monkey to prevent the wood from splitting when striking the pile. This method appears better than bolting the handles through the wood or fixing them to the collars at the ends of the monkey.

The road bearers were round timbers of 9″ minimum diameter or 11″ mean. To take a 3′ 6″ gauge steam engine, for which the bridge was designed, two road bearers of this size would be required under each rail. As however trollies of 2′ 6″ gauge only were available for testing the bridge, and as double road bearers would have necessitated felling more timber, the gauge was reduced to 2′ 6″ and one road bearer placed under each rail. The road bearers were calculated to take a 10-ton live load with a factor of safety of 3. The joints of the road bearers over the capsills were skew joints; the road bearers were spiked to the capsills with 10″ spikes countersunk.

The sleepers were of half round timbers, notched to receive the rails and spiked to road bearers with 8″ spikes.

The rails were single-headed 56-lb. rails without chairs. The rails were connected together with fishplates, and spiked down to the sleepers with railway spikes.

To test the bridge two trollies connected together, giving a 9′ 8″ wheel base, were loaded with 10 tons of rails to represent a 2′ 6″ gauge steam engine; and were hauled across the bridge several times at varying rates. The deflection of the road bearers of the centre span and of spans near the end of the bridge was found to be ½″; there was no trace of settlement or disruption in the bridge.

---

8. RAISING TRESTLES IN DEEP WATER.

The following method of raising two-legged trestles is extracted from a work by Major V. Deguise, Belgian Engineers.

It has been tried at Chatham and might prove useful, particularly in deep water. It has the advantage that the trestle, when raised, has the necessary longitudinal bracing and handrail already fixed.

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A frame of light poles, consisting of two legs and two diagonals, is lashed to the butts of the trestle legs, and the handrails are lashed to the tips, all with a square lashing rather loosely put on.

Both frame and handrails are then allowed to fall back until the lashings tauten and assume an angle as shown in *Fig.* 2.

Light ropes are then made fast to the end of each handrail and to the legs of the light frame.

The whole is then floated out to the bridge head, being steered by means of the ropes.

The legs of the light frame are then made fast to the legs of the last trestle in bridge; and by pulling on the handrail ropes, the trestle is easily raised into position as shewn by the dotted lines in the drawing.

Before floating out, the handrails and the legs of the light frame must be carefully measured and marked at the points where they are to be lashed to the bridge trestle.

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OUR IDEAS ON PERMANENT FORTIFICATION: WHAT ARE THEY?

By Capt. G. Walker, R.E.

Two articles in the January number of this *Journal*, independently conceived but treating of the same subject from different standpoints, seem to indicate that we are not altogether indifferent to the fact that our own profession is worthy of study in spite of all that is said to the contrary.

The history of the influence of foreign policy on British coast defences is a subject which, except to the very few, seems, as far as can be gathered, to be quite outside the average man's idea of practical politics; and yet we soldiers prate so much of Military History! Our ideas as to the uses of the study of Military History seem to be bounded by the horizon of that bugbear "D." Is this right? We profess to be Military Engineers. Do we individually ever study that subject outside the official text books? Do we ever set ourselves to think big upon the subject? Have we, any of us, the personal ambition that we may one day be able to mould the defensive policy of the Empire? Our fathers have done it before us, why should we not do the same?

These questions must, it is feared, be largely answered in the negative. The reasons for this state of things seem difficult of elucidation, but there is one which seems to be fairly clearly marked; everybody nowadays seems to be striving to get away from his own profession in order to dabble in somebody else's. So the profession of the Soldier Engineer, than which we venture to think there is nothing more honourable, becomes, to use a modern vulgarism, "left." In these latter days Military Engineering has come to be considered the profession of everyone who wears a red coat, and this is right to a certain extent: every soldier must be able to help himself at a pinch by artificial means. But Military Engineering does not end there. The man who professes it must be soldier and engineer as well, and must be trained to bring his scientific knowledge to the assistance of his military instinct.

The foregoing pious opinions may seem rather indefinite, and the question will be asked—what does it all mean? Let us take a definite branch of the soldier engineer's profession and ask ourselves some questions about it.

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Permanent Fortification is said to be a dead art, so far as Englishmen are concerned. "Britannia needs no bulwarks," sang the poet. Doesn't she? It may be waste of time to argue the point; but Britannia will probably, at no very distant date, be very sorely in need of a knowledge of other people's bulwarks. "We shall never again undertake a siege," say others. Shall we not? British military history bristles with sieges. Is military history alone never to repeat itself? and further are we so unlikely to be besieged that the conduct of sieges by other people is not worth a thought? Have we been such unerring prophets in the past that we can afford to pin our faith on our opinions as to the future?

These questions seem pertinent enough and direct enough. The answer would seem to be that the teachings of history ought not to be disregarded; that we professional Military Engineers, instead of allowing the subject we profess to be dropped, should strive to create a school of thought which will be the standard in our own country at least.

At present it is to be feared that we are very far from having any organised school. This is due to a want of cohesion, and also to the fact that, at present, it is impossible for anybody to get any military information other than that contained in the rather highly priced efforts of individual authors.

It is not intended here to carp at the individual author: far from it. The man who has the energy to produce any work, however small, is entitled to all praise. What we want, however, is not isolated individual effort but an organisation within which the individuals can usefully labour and through which the result of these labours may be made available for the use of their fellows.

To carry out this idea we want a sort of "Bureau of Information," which will sift and arrange intelligence supplied to it and furnish professional advice to anybody in need. To do this a director and staff of officers would be required, who should have no other duties than the collation of information and the revision of our professional text books. It is a work that would require a wide knowledge of things military, especially as regards artillery, a branch of study which is often neglected.

So much for the abstract ideas engendered by Colonel Ruck's article. We will now turn to that by Major Clayton.

Here we have a creditable sample of individual effort. The article it is true contains an avowed criticism of two of the few standard works on fortification in the English language. But both books were published several years ago, and Major Clayton's object was no doubt to show what modifications have become necessary on account of the development of artillery and firearms. Sir George Clarke, who wrote with the specific object of infusing some elasticity of method into the art of fortification, did not say that traverse protection was never

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to be used if required, but that the engineer should be free to use any artifice within his reach to meet the tactical conditions of his day. Fortification is not an exact science and Sir George's book certainly made this clear.

To deal with Major Clayton's ideas of detail :—Taking the plans generally they seem very complicated as regards the slopes. The desired protection from shrapnel could probably be much more easily obtained. Steel loopholes are no doubt admirable, but, from the Japanese experience of the effect of shrapnel, it is probable that in the future some form of overhead cover in addition to loopholes will be essential for the firing line.

The question of artillery is perhaps the most crucial of all those raised by Major Clayton. It is governed entirely by the tactical requirements of individual positions. But, in the absence of any special local conditions, it seems more reasonable to assume that artillery should not be put into infantry works and for the following reasons :—

The best position for any weapon is determined generally by its power and the best method of protecting it. The powers of guns and rifles differ greatly and it is a reasonable assumption that, this being the case, the best places for them will as a rule not be identical.

The power of indirect fire from modern guns and howitzers is great, that of rifles small—why put them in the same place ? By doing so the position of the latter is advertised to that arm of the enemy to which they have no power to reply. Mobility also is reduced to a large extent and this is an important point.

By these remarks it is not intended to deny light Q.F. armament a place in infantry works in particular places ; but only to point out that, in considering any scheme of defence, the best rule to go by is to put each class of weapon where it can best do its work.

The question of the form of superior slope seems rather laboured in the article under review. The actual site will largely affect the question. The idea of counter works on the parapet seems of questionable value. Counter-attacks would probably be more effectively carried out from positions on the flanks of and outside the redoubt.

The positions of electric lights are of great importance. It seems questionable, however, whether they are best placed in the works. Flank positions would probably be better, but these would entail difficulties (not insuperable) of installation.

Generally, it would appear that Major Clayton has regarded his redoubt too much as a separate and self-contained entity, and has not laid sufficient stress on the fact that, to be really effective, all works must complementary to those around them. As regards design simplicity and inconspicuousness, being the main necessities nowadays, must take the first place.

One word must be added in respect of coast defence. Major

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Clayton's deductions from the siege of Port Arthur appear to be correct. There is a danger, however, in arguing entirely from one actual case. No one can be responsible for the methods of attack resorted to by others, and it seems of questionable prudence to lay down anything very definite, except, perhaps, that heavy ships will not probably put themselves in the way of destruction by coast batteries as their *rôle* is the destruction of their own kind at sea.

Boom defence covered by guns capable of stopping the blocking merchant man *and* a possible torpedo boat would seem a better way of putting it; and also, in certain places where anchorage has to be denied to the enemy, even the discounted submarine mine may be of use.

This article has been spun out beyond its intended limits, and possibly some statements have been made which will not receive universal approval. Its intention has been firstly to point out how much we all can learn from the previous history of our profession; secondly, to congratulate Major Clayton upon his effort to start discussion on a subject that receives but scant attention nowadays; and lastly, to offer some criticisms on his ideas, which may induce others to take a hand in the discussion and thus to some small extent help everybody.

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NOTES ON SHELTER TRENCHES.

By Bt. Col. J. E. Capper, c.b., R.E.

THE following notes on Shelter Trenches were written two years ago for private circulation and criticism; they have since then been slightly revised.

I have long thought that our text books on Field Works pay too little attention to general principles; and though the Manuals for Infantry Training are thoroughly excellent, they are of necessity so compressed that it is difficult, without very close study and much thought, to apply the principles contained therein to individual instances.

Since these notes were written Capt. H. F. Thuillier, R.E., has published a work which contains much that is also included here. I venture to hope, however, that these notes may still be of service; and they will answer their purpose if they lead to discussion, and ultimately to the embodying in our text books of principles so clear that no officer can have any hesitation as to the position and nature of defences suitable to the tactical conditions of the moment.

That these clear principles are required, and that nothing is "obvious" to the untaught intelligence, may be illustrated by the following incident:—

At a certain examination of officers for promotion to Major and Captain, the Examining Board being one which no one would accuse of want of military capacity, and the examinees being well up to average standard, one of the problems was the fortification of a rear-guard position along a ridge sloping steeply to the enemy. All of the examinees with the exception of one R.E. officer devoted their attention to attempting to cover the dead ground close under the ridge, and the President himself expressed surprise that this officer should have neglected the dead ground. However, on being informed that this officer proposed to withdraw his troops long before the enemy reached the dead ground, the President was entirely satisfied; but this simple and obvious view of the matter had never occurred to him nor to any other of the examinees.

The positions chosen for Shelter Trenches, and the nature of the Trenches to be constructed, must vary according to the purpose for which they are to be occupied.

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The enormous stopping power of the modern rifle has necessitated modifications in the principles governing the choice of positions for the trenches.

THE OFFENSIVE—DEFENSIVE.

In the choice of a position where battle is to be accepted, the main point is to obtain a clear field of fire as deep as possible over the ground in front.

If such a field of fire can be obtained over *open ground* up to 1,000 yards from the position, an enemy attacking will probably be brought to a stop on it.

If he is able to advance over *open ground* to within a very short distance of our trenches, he will in all probability be successful. He could not reach there if our fire was effective, whilst the moral effect of such an advance would probably induce our retirement before he arrived at the closest stages.

It follows, therefore, that in such a case dead ground *immediately* in front of our main trenches is not a fatal disability; and that the main trenches should not be advanced down a slope in order to cover their immediate foreground, if, by so doing, the view of ground within decisive range of, but further away from, our position is thereby lost. Such dead ground must however be covered by advanced trenches at night and in misty weather, and may often be searched by other trenches further along our line.

When, however, cover for the enemy exists to within a short distance of our main position, or where it is impossible to see from it any ground except the immediate foreground, our trenches must be sufficiently advanced to enable us to sweep the immediate foreground with fire.

Trenches in a battle position may, therefore, be well advanced to the forward edge of a plateau, or down the forward slope of, or at the foot of, a hill, provided the view is not lost by making them at the lower levels.

REAR GUARD ACTIONS.

In a rear guard action, it is not our intention (except under extraordinary circumstances) to stand a close attack. Our object is to delay the enemy and force him to deploy, and then ourselves to retire to another position without the risk of excessive loss.

If we can obtain a good view of ground about 1,200 yards to 1,500 yards in front of our position, we can select the front of a plateau; but we should not go down the front slopes, as we shall then have to retire up an exposed slope.

If, owing to undulations of ground or cover in front, we cannot see the enemy till he arrives within decisive range, it is best to occupy the rear edge of an open plateau. He will be held for a time at the far

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edge of the plateau, and we have a better chance of retiring with safety down the unexposed slopes than we should have of retiring under his fire at decisive ranges across an open plateau. For such positions dismounted horsemen should be detailed if available.

If there are woods on the plateau, the front edge of these woods must be held, and we can retire through them under cover from the enemy's view.

DETACHED POSTS.

In detached posts, where the object is to prevent the enemy reaching a definite point, such as a bridge, stores, etc., so that he cannot destroy it, it matters little how close he can get to the object as long as he cannot actually reach it.

In these cases we require above all to be able to sweep the ground immediately in front of our trenches, and the trenches should be pushed forward in order to obtain this object, even if by so doing ground at a distance is hidden from view.

If the garrison is sufficient, a double tier of trenches may be used to sweep both the immediate and further foregrounds.

Trenches, forming part of a battle position, which are advanced beyond the main position, or where the enemy can advance under cover to 200 or 300 yards, are governed by the same principles as those of detached posts.

CONDITIONS GENERALLY APPLICABLE.

In all cases the following conditions should be fulfilled as far as possible. They are placed in order of importance.

1st Condition.—The shelter trench must be so placed that it can command a view of the ground on which it is to bring fire. Except in rear-guard actions, where long range fire is mostly employed, the field of fire must be cleared as far as possible.

2nd Condition.—Concealment must be considered, both to avoid giving a definite mark to the enemy and to hide the exact position and numbers from the enemy. The shorter the range the more important is the question of concealment of the individual man. Very slight protection to men behind bushes, or in very broken ground, where their heads cannot be seen, is better, at very short range, than thick parapets, over the tops of which men's heads plainly appear. Even the best troops may be disinclined to expose themselves over a parapet in order to fire at a more or less hidden enemy, who is firing at close range ; but when concealed from view only, they quickly realize that it is safer for them to fire than to lie without firing.

Where a trench cannot be concealed, it is often well to give head-cover in the shape of logs of wood, or some contrivances raised a few

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inches above the parapet, which, though not bullet-proof, prevent the enemy seeing individual heads at which to take aim.

Care must be taken that, in placing shrubs, grass, etc., in front of the trench to conceal it, the cover is not so thick that the view is unduly interfered with. At ranges over 200 yards a good natural or artificial background is often sufficient, as it renders men's heads very difficult to see.

Where parapets are necessary, every endeavour should be made to blend them with the general appearance of the ground. For this purpose it is desirable to preserve the top layer of soil dug out, including sods, etc., in order to have material at hand to cover the newly excavated earth.

3rd Condition.—Bullet-Proof Cover.—At long ranges, where artillery fire is to be apprehended, and where the enemy's infantry fire is practically a hail of unaimed bullets, it is a matter of chance whether a particular square foot of ground is hit or not. With bullets falling heavily on a position, men in scrub or broken ground, not well protected, may suffer severely from this fire; therefore every endeavour should be made to give the men as much protection as possible.

Condition 2 must not, however, be lost sight of. Large mounds of newly-turned earth will attract both artillery and infantry fire at long range.

If the position is known to be held, as in detached posts guarding definite objects such as bridges, invisibility of the general lie of the trenches is not so important as in battle positions, where the enemy must remain uncertain as to the position actually held, owing to reconnaissance being very difficult.

4th Condition.—Deception.—Provided your general position is known, try to deceive the enemy as to your exact position by dummy trenches, so as to deflect his fire from the trenches you are really holding. These dummy trenches should be well defined, and should, if possible, have head-cover or loopholes, so that the enemy cannot tell whether they are occupied or not. They can be placed either in advance of or behind the actual line, or in gaps of the line.

Care must be taken that they are not so placed that bullets aimed at them are likely to fall or ricochet into the actual trenches; that the fire from the trenches is not masked by them; and that they will not interfere with making counter-attacks.

If made in advance of the real position they must not afford cover to the enemy if he reaches them.

It follows that, as a rule, they are better made either in rear of or alongside the real trenches. On flat ground it is preferable to use them in gaps; and on sloping ground to make them higher up the hill than the real trenches.

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GENERAL.

Trenches need not be continuous, and should not, as a rule, be in straight lines. The parapets should not be carefully dressed off; and all sharp angles should be avoided.

If time admits, zigzag communication trenches can be made, joining up the outlying trenches, or joining these with others in rear in which supports can be placed.

Unless the ground is very favourable, without such communicating trenches it is almost impracticable, when the enemy has arrived at decisive range, to reinforce the trenches from one another or from supports, except by night. They should not, however, be started (unless there is a large superabundance of labour) until the field of fire has been cleared where necessary and the fire trenches are finished.

The principle of keeping men in groups should be adhered to in making rifle pits or short trenches. A trench should, therefore, as a rule, be at least big enough to hold a group. If detached bushes, etc., lend themselves to the making of rifle pits for only one or two men, these should, as far as possible, be grouped together, so as to keep the men of one group in close touch.

No definite rule can be laid down as regards the height of a parapet above the ground; it must vary from point to point, according to the accidents of the ground itself. But parapets should be as low as is compatible with a proper view of the ground which has to be covered by fire. On steeply sloping ground, however, in order to cover the scar made in excavating the back of the trenches, it is often necessary to throw up a comparatively high parapet. This parapet should be carefully treated, so as to blend with the hillside.

If the ground in front is sufficiently even, and time permits, parapets may be altogether dispensed with, the whole of the earth excavated being removed to a distance.

Spreading earth generally makes a mark. Where there is surplus earth it may often be usefully employed by making irregular-shaped mounds as backgrounds behind trenches; and if this can be done, and the mounds made to resemble the foreground, it is the best method of disposing of the earth.

Where there are bushes or banks in the immediate background of the trench, the dug earth can be spread behind them.

In laying out the actual line of trenches, the eye must be placed at the height above the ground to which the parapet is to be raised; it often happens that a view, which is an excellent one for a man standing up, is rendered, by small folds in the ground, very indifferent for a man lying down on the same spot.

It is often necessary, in order to search folds of the ground close to the main line of trenches, to place outlying trenches in front of the

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main line. Care must be taken, wherever such trenches are used, to see that the men in them are protected from the fire of the trenches behind them, by the ground itself or artificially. In the latter case a considerable portion of the earth dug out from the trenches can often be placed in rear. If it is required for protection in front it will be necessary to put up special parapets to protect the rear of the advance trenches.

Where trenches are broken back, as flanking trenches, they are liable to be exposed to enfilade fire, and sometimes to reverse fire from portions of the enemy's position. This defect can often be obviated by utilising the fall of the ground, making the trench higher up a hillside at the end which is nearest the enemy's position, and also by avoiding straight lines in plan. It may sometimes be necessary to put earth in the rear. This earth need not, if time be short, be made bullet-proof, if it can be so blended with the surrounding ground that the actual position cannot be seen from the enemy's position.

Where time admits, trenches should invariably be studied from the enemy's point of view. Parapets placed well down a slope will sometimes be found to be on the sky line if looked at from the enemy's position, and the sky furnishes the worst possible background for a trench.

SECTION OF TRENCHES.

In deciding on the section of trench to be dug out, it must be remembered that at long ranges the angle of descent of the bullet is great, and narrow deep trenches therefore afford the best protection. At short ranges, where the angle of descent is small, broad shallow trenches will often give as good protection as deep ones.

CONSTRUCTING TRENCHES.

The principles are the same as those which govern the taking up of a position.

The general line of trenches will be given by some superior authority. Each unit will be told off to construct trenches along a definite section of the front, and the exact position of either end of their line will probably be given them, together with the general line they are to adopt. Individual officers commanding units should then decide on the actual position of their trenches.

These trenches may be considerably in advance of, or withdrawn from, the general line, provided sufficient fire is given to the front between the extremities of the line, and that the trenches are not so far advanced or withdrawn as to mask fire from, or be masked by, adjoining portions of the main line of trenches.

In telling off parties to construct trenches, it must be remembered that those on the most important points of the line must be

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constructed first; and that clearing, where necessary, must go on at the same time as, or even before, the trenches are constructed.

Each commander, in his own degree, must therefore decide on the points in his portion of the line which obviously must be held, and divide his working parties accordingly (allowing first the necessary parties for clearing), and order each party to begin on the centre portion of its own position and work outwards.

Senior officers must most carefully avoid trying to do too much detail work themselves. It is only by entrusting the most junior officers with the actual location of each trench that all can get quickly to work. There is no reason why a junior officer, or an intelligent N.C.O. or private, should not be able to decide on the best site for a small trench as satisfactorily as the best qualified Engineer, *provided he has been properly trained to understand what he is doing.*

If time admits, or if there are more men in any party than are required to construct the trenches on the position allotted to that party, they can be distributed on the less important portions of the line.

If any attempt is made to start at one end of the line and work towards the other end, it may often happen that, from want of men and want of time, important points remain without any sort of defence, while less important points are well fortified.

In the same way, in occupying trenches that have been constructed by other working parties, occupy the most important points first; spread out afterwards, if there are men enough, along the less important trenches.

LOOPHOLES.

The chief object of a loophole appears to be to enable a man to fire with the minimum of risk of himself being shot.

It narrows his field of view, and is, to this extent, undesirable at any range; and this defect is much aggravated at night.

At short ranges, except where it is concealed by heavy shadow or by scrub or grass, etc., it not only affords an excellent mark to the enemy, but tells him the exact point to aim at, and is often a source of weakness in consequence.

At long ranges, the protection afforded by loopholes is greater than that afforded by open parapets; but it is well to remember that the constant use of loopholes is apt to have a demoralising effect on troops who may at any time be required to act on the offensive, where they will miss the complete cover to which they have become accustomed.

At ranges at which a man's head would be visible, men firing over a parapet, with their heads merely concealed from the enemy's view, will probably not suffer more than the same number of men firing through clearly seen loopholes.

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In walls, blockhouses, or fortified dwellings, necessarily exposed to the enemy's view, loopholes must be used. But their disadvantage can be minimised, as they can be made very small without much restricting the field of fire ; and their exact position can be hidden by painting sham loopholes, or by knocking bricks out of the outside of the walls irregularly and at different levels, so that the enemy will have no more exact target to aim at than the whole building itself.

OBSTACLES.

The main points to remember about an obstacle are :—

(1). That it is not meant to serve as an insuperable barrier to the enemy, but to keep him exposed under fire as long as possible.

(2). That, to be of any use, it must be placed where it is well under fire from the trenches, and close enough to them to be protected at night.

(3). That it must not be so thick as to afford protection or effective concealment to the enemy.

(4). If possible, it should be so placed that the enemy will come on it unexpectedly.

(5). It must not prevent counter-attack.

RÉSUMÉ.

BATTLE POSITIONS.

(*a*). Select positions from which you can obtain a good field of fire over a stretch of open ground between ranges of 200 and 1,000 yards, or more, from your position, and clear on this ground.

If you can do this do not fear too much any disadvantages of your immediate foreground.

(*b*). Get well forward on a plateau or down the slope of a hill.

(*c*). Use deep and narrow, rather than broad and shallow, trenches.

(*d*). Conceal your general position, and do not put up dummy trenches which give it away.

(*e*). Where the enemy can approach under cover to close up to your position, treat this portion of your position as a detached post.

REAR-GUARD POSITIONS.

(*a*). Select positions from which you can retire in comparative safety, and

(*b*). From which you can bring fire at 1,500 yards, or over, to bear on the enemy.

(*c*). Conceal your actual position.

(*d*). Use dummy trenches well in advance, even up to 500 yards or more, of your real position.

(*e*). Keep at the rear edge of an open plateau, rather than have to retire over it under heavy fire.

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DETACHED POSTS.

(*a*). Be able to fire over your immediate foreground, and clear it.
(*b*). Use every endeavour to conceal the individual man.
(*c*). Use dummy trenches freely.

IN ALL CASES.

(*a*). Place your trench where it can fulfil its object. To do so place your eye at the height to which the parapet will be raised.
(*b*). Conceal your parapet as much as possible and make it look like the surrounding ground.
(*c*). Make your parapet bullet-proof.
(*d*). Avoid the sky line. Where a parapet cannot be concealed, give head cover.
(*e*). Avoid high parapets, except for command, and on steep hillsides, where they may be necessary to conceal the scar made by the back of the trench.
(*f*). Study your trench from the enemy's point of view.
(*g*). Protect dead ground by outlying or advanced trenches.
(*h*). Do not spread the earth from your trench so as to make a mark. Use any not required for your parapet to form a background, or hide it away unless it is required for dummy parapets.
(*i*). Protect your men from enfilade or reverse fire.
(*j*). In starting work, tell off a party to clear, and distribute the rest on the more important points, leaving the less important to be done later.
(*k*). In hiding your trench, do not unduly interfere with the view from it.
(*l*). Avoid loopholes at ranges where they form a distinct mark to aim at.
(*m*). In using obstacles place them where they are under effective fire from the trenches.

ILLUSTRATIONS.

INVISIBILITY OF MAIN POSITION.

The Boer trenches (at Colenso and Magersfontein particularly) were very well hidden. Quantities of ammunition, both gun and rifle, were expended by our troops with comparatively small effect, as no definite objects could be seen at which to aim.

INVISIBILITY OF INDIVIDUAL MAN.

At the attack by the Boers on a post defending a bridge in the Orange River Colony, the enemy at night got up in thick scrub close to some small outlying trenches manned by a few men.

Four Boers had got down into a small sandy ravine 40 yards from

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the trenches, where they had ample protection, but had to put up their heads to fire. All were killed.

From heaps of empty cartridge cases picked up afterwards, it appeared that about a dozen Boers were in some thick scrub on the far side of the ravine, from 60 to 100 yards from the trenches. The ground there was level, and there was no protection except from view. None of these men would appear to have been touched, and all got away.

Twelve Boers on open ground got into a deepish hollow about 100 yards from the trenches on another side. Their heads were clearly seen as they fired. After a few shots they were no more seen. On the enemy retiring five hours later a white flag was put up. It appeared that one had been killed, one was wounded trying to get away, the other ten sat down under cover for the rest of the day and then surrendered.

DECEPTION.

In a post where dummy trenches were made, and where trenches existed which had been abandoned, it was found that, on attack, the unoccupied trenches attracted as much, if not more, fire than those near them which were actually held.

In the same post, a number of greatcoats laid along the back of a railway embankment, which could be taken in reverse, suffered considerably from shrapnel, whilst not a man of the garrison was hit by this fire.

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THE ORGANIZATION OF CIVILIAN LABOUR FOR DEFENSIVE WORKS IN CASE OF INVASION AT HOME.

By MAJOR F. A. MOLONY, R.E.

THE recollection of the undue confidence with which the French entered upon the war of 1870 should convince us that we must allow the *possibility* of our Navy suffering a *débacle*. The question whether it be wiser to make this more improbable by greatly strengthening the Navy, or whether we ought to provide a second line of defence on land, is beyond the scope of this paper. Sufficient for the present purpose if we agree on a few collateral propositions.

Organization of civilian labour desirable in any large war to maintain internal order

1st. Any war with a naval Power will greatly increase the number of the "unemployed."

Certain lines of industry will be stimulated, but the risk in importing raw materials will cause many factories to shut down; and, as the price of foodstuffs will rapidly rise, the misery of the unemployed is likely to result in serious riots.

This difficulty is similar to famines in India, and must be met on similar lines, *i.e.* by "relief works." The best will be those which strengthen the Navy, but all the dockyards of the kingdom will not afford work for all the unemployed. If there be the smallest likelihood of invasion, fortification works are next best; because they can employ all trades, can be spread over a large area, and will not be stopped for want of materials from oversea.

and to repel invasion,

2nd. Should one of our Continental neighbours gain naval supremacy in the Channel, invasion will be immediately attempted, in preference to a "starving out" policy.

This course would be demanded by the public of those countries in consequence of the universal instinct to use familiar weapons. As David decided to keep to the "proved" sling, so would Continental Powers make their first effort with their great armies.

which, if made, will be with a larger force than we can meet in the open.

3rd. Should a footing be gained on our shores, the enemy's transports will make repeated passages till they have landed a larger force than we can contend with in the open; because they have the armies to send, and the stake is sufficiently valuable to be worth risking them.

Our enemies may get embroiled with other Continental Powers, and our Fleet may recover the supremacy of the Channel; but we should not count on these advantages. In providing for the great

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dangers we cover lesser ones. In guarding against a serious invasion, we reduce the danger from raids to a little local and temporary damage.

4th. We maintain both auxiliary troops and fortifications, which are only intended for use in case we are invaded. This expenditure is indefensible unless we make all other reasonable preparations which are essential to repel an invasion. One of the most important of these preparations is the subject of this paper.

This organization needed to complete our defensive system.

In the *R.E. Journal* for November, 1905, 'Nemo' recommends that in war C.R.E.s be allotted to Engineer Districts and not to Divisions. This was the plan followed in South Africa at an early stage of the war, for the simple reason that the officer in charge of engineer works in progress cannot be frequently changed.

Organization by Districts.

Our engineer organization for Home Defence must therefore commence with the division of the United Kingdom and Ireland into Districts.

Existing arrangements can remain in those cases where the District includes some fortress in which its headquarters and depôt can be placed, and to which all its staff can be withdrawn if pressed by the invader. To permit of the collection of large numbers of workmen, the London defences will include several Districts. Harwich, Dover, Portsmouth, Portland, Plymouth, Pembroke, Newcastle, Queensferry, must be headquarters of others; perhaps also Sheffield and Birmingham, if it is determined to fortify these towns on account of the warlike stores they manufacture.

The London defences will cover so much ground that the question of communications is more important than any other tactical consideration. Hence each Engineer District will comprise as far as possible the lines of one railway company. Thus there will be 3 Districts south of London; the first astride of the S.E.R. (including Chatham), the second astride the L.B. & S.C. Ry., the third astride the L. & S.W. Ry. There are more lines north of London than we need Districts, hence two of them will be told off to feed the first two Districts mentioned above, which, being nearest to the Continent, are the most important.

The boundaries between these districts will be traced down to the coast, partly to define the areas from which each C.R.E. should draw men and materials, but chiefly because defence works will very likely be undertaken at the most probable landing beaches.

Coast defence. Reasons for attempting it.

It is often assumed that the forces available to resist invasion should be kept massed at a few central points, with the object of moving against and crushing the invader as soon as the direction of his main attack is evident. This movement would now be carried out by railway, and as easily if the troops to be moved are scattered at a number of railway stations as if concentrated at a few. As all the best landing beaches near London have railways near them, the

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disposition of troops for their defence will scarcely, if at all, delay the assembly of a force to crush an invader; especially as the bulk of such troops would not be actually on the coast but brigaded at junctions in rear.

The length of time for which the invading force first thrown ashore can hold its ground largely depends on the amount of ground it can seize. This amount will be much less if it be strenuously opposed from the very start than if the invading cyclists and mounted infantry are allowed to move a full day's march inland while the defenders are arranging their crushing movement.

It is extremely difficult and unusual for a force moved oversea to bring with it all the transport and supplies it requires. If the invader be opposed only by a screen of troops sufficient to prevent his cyclists dashing inland, the defence will gain the opportunity to remove all transport, cattle, and part supplies, and the difficulties of the invaders will be immensely increased.

The range of modern rifles has allowed defensive positions to be held with very much fewer troops than was dreamt of before 1870. Hence the defence of all the landing beaches from Harwich to Portsmouth could be undertaken by a quarter of our land strength, thus forcing the invader to choose a landing place involving a longer line of march to his objective, London.

Doubtless the enemy's transports would be escorted by cruisers which would direct a hot fire on the defenders; but if these latter were entrenched, and held their fire, they would suffer very little. Even when they opened on the boats, their position would not be obvious to the cruisers. A very few cool defenders would inflict heavy losses on troops in boats.

Still it might be better for the defence to take up a line half a mile or a mile behind the beach, which would make them practically safe from the cruisers and still leave too narrow a strip to give the invaders a fair foothold.

In any case the line to be taken up would need to be strongly entrenched, and civilian gangs would probably have to be employed on the larger works. A great deal of railway work would also have to be done; but this would doubtless be arranged for by the Managers of the Companies, who are officers of the Railway Volunteer Staff Corps.

Possibility of coast defence being undertaken involves dealing with large areas.

The chief point is that the work to be done would probably be spread over a very large area; and the most important part of it, viz., the defences of London, would probably have to be pushed on without the assistance of the troops, who would be occupied elsewhere till the invader had established his landing.

This shows clearly the necessity of very accurate plans of all defence works being prepared beforehand. They will have to be executed by men who have never seen a defensive trench or wire

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entanglement: and mainly supervised by others whose ideas on the subject of defilade, etc., are of the vaguest. Each work should be drawn out with numerous sections on a scale not smaller than 30 ft. = 1 in., and plans prepared on scales of $\frac{1}{2500}$ and 6 in. = 1 mile, showing everything which it is desirable the civilian gangs should do prior to the occupation of the works. The $\frac{1}{2500}$ and 6 in. plans should also show the order in which the various works are to be undertaken. Hence careful plans needed.

For important works, tracing plans should be prepared, giving all dimensions, and starting from easily found landmarks.

We now come to the actual organization, and will take first the personnel.

Over each District there would be a C.R.E. with the usual staff, strengthened by a few extra clerks and draughtsmen. Personnel.

He would subdivide his district among 4 or 5 R.E. Division Officers. Under these would be 20 or 30 architects, civil engineers, or builders, graded as Temporary Civil Clerks of Works, and about 150 builders' foremen as Temporary Civil Foremen of Works. Each of the latter would supervise a gang of 10 to 30 labourers, who would be kept to the same class of work. It would be impossible to teach each lot everything. Each Clerk of Works should have under him gangs for trenches, gun positions, wire entanglements, clearings, roads, and two or three for redoubts; and with these should be able to strengthen a mile or two of front.

The greater difficulty is the supply of all these people with tools and materials. Tools and materials.

To effect this an "Officer in Charge of Stores," preferably an O.S.D. officer, would have his headquarters at the most important Railway goods station in the District. His business would be to inform the S.O.R.E. what tools and materials were available, and to distribute them to D.O.s as the C.R.E. directed.

He, the S.O.R.E., and the District Surveyor, should constitute a Board, meeting daily, and empowered, within a few guiding limits as to price, to buy what was required.

Advertising should be done by the Chief Engineer of the Fortress; and must describe exactly what is required, where the District Buying Boards meet, and where samples can be seen to govern the supply of such articles as sandbags and anything else requiring to be specially made to meet the demand. The Staff of the Chief Engineer would also have to arrange for the distribution of articles superfluous in any District among others reporting a deficiency.

The question of paying the working gangs is a difficult one. The R.E. officers would be much too busy to be made responsible for it. The best way would seem to be to make the Clerks of Works primarily responsible, by giving each an Imprest Account for which the Foreman of Works' Pay Sheets would be vouchers; the whole to be checked by the time fixed for the cash payments being always Pay.

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notified to an officer A.P.D., who would often be present, and whose assistants would constantly count the gangs.

It might be sometimes possible to institute piece-work or task-work, but generally the patriotism of the workmen must be appealed to and relied on to get a fair day's labour. The contract system is far too cumbrous to be suitable at such a time; it takes too long to get started, and does not lend itself to the changes inseparable from military operations.

Shelter. The large gangs of workmen we propose to employ would not be able to get lodgings near their work, a great deal of which will be on the Downs, where dwellings are few. It would therefore be advisable to begin work by putting up shelters for them. Where military reserves can be advantageously posted, camps would be formed by stretching tarpaulins, sails, or carpets over scaffold poles rigged as for ridge tents. Nearer the front, the shelters would be of corrugated iron, so that they could be kept very low and inconspicuous. In the redoubts they might be made of brushwood, and at a few important points bombproof field casemates might be needed.

Food. Though we must help our workmen as to shelter and water supply, we need not do so as to food. Sutlers will soon find that money is to be made by supplying their demands. If not, each gang can send a man to forage, and they must pay their own cook. It is undesirable that the superintending staff should be mixed up with questions of supply.

Fighting pioneers. When advertising for workmen, it may also be desirable to add that joining a Corps of Pioneers will carry either free rations or extra pay. The conditions would be that the man must take the oath of allegiance, submit to military law, wear uniform, and drill or shoot for an hour every evening. These men will be drafted into the redoubt gangs, and should soon be fit to defend them, for he must be a poor-spirited man who will not fight for the work of his own hands.

Movements. It remains to discuss how these gangs are to be moved about, for such movements are sure to be necessary. For instance, they might in the first instance be formed on the coast; when an invader has landed, these would probably be moved back by rail to the London positions; when the Field Army is driven in on these positions, the civilian gangs would be moved back to a second, and perhaps eventually to a third, line of defence.

The 7 or 8 gangs under a Clerk of Works would make the best unit for movements, as it would comprise men trained in every sort of work. Hence it might be called a "Company of Workmen." If occupied on the London defences, it would have a few carts belonging to it, usually busy in shifting materials on the works, but during a "move" available to carry heavy tools and kits. Shelters would not usually be moved; the men must bivouac in the new position till they can rig up new shelters.

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When used to reinforce an existing line they would usually be sandwiched in between two companies already at work, taking over some jobs from each.

D.O.s of sub-districts.

Division Officers' sub-districts would be made to correspond with the areas occupied by tactical units, usually Brigades, by the transfer of these "Workmen's Companies" from one D.O. to another. As the D.O. would not be responsible for their pay, this could be easily done. The D.O. would live as close as possible to the headquarters of the Officer Commanding the tactical unit. Any alteration in the works required by the latter would be carried out by the D.O. without reference, as long as it did not affect neighbouring sub-districts, when arrangements would of course be made with their C.O. and D.O.

Their relations with O.C.s Troops.

Civilians with the Field Army.

A good many civilians are also likely to be required with the Regular and Volunteer R.E. units; these would require no Civil Clerks of Works, as they would be under the direct orders of the officers of those units. Otherwise their organization could be very much on the lines already described. As they would be moved about more frequently, they would require more transport and probably some tents. "Companies of Workmen" could be transferred from the Field Army to Fortress work, and back again, as the exigencies of the moment required.

It is only necessary to mention the Railway Pioneer Regiment in South Africa to remind R.E. officers of what can be done by organized bodies of civilians.

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A NEW METHOD OF POWER PRODUCTION:

The Suction Producer Gas Plant.

By Major T. E. Naish, R.E.

As the question of cheap power is always interesting to an engineer, attention may usefully be drawn to the suction producer gas system, which has many special points of interest.

It is a system by which coal is turned directly into gas by the simplest possible means (through the agency of steam) and used directly in a gas engine.

The engine acts as its own gas maker, and automatically regulates the rate at which gas is made to suit its requirements.

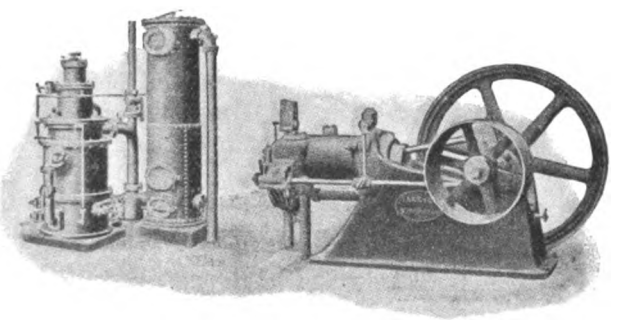
This system may claim to be "the cheapest power on earth," even beating water-power, except in the rare circumstances where fuel is very dear and an exceptionally high fall is available ; for it should be remembered that the interest on the large capital often required for developing water-power must be added to the annual cost.

FUEL COST.

Here are some figures that offer themselves for criticism :—the four suction producer gas plants tried at the recent Show of the Highland and Agricultural Society of Scotland at Glasgow ran at a cost of less than $\frac{1}{20}$d. per B.H.P. per hour (see *Engineering* of 17th November, 1905). The fuel used, however, was exceptionally cheap, being Scotch anthracite, costing 9s. 3d. per ton.

Most makers of suction producer gas plants modestly claim $\frac{1}{10}$d. per B.H.P. per hour ; based on a fuel cost of 21s. per ton, for which price (or less) Welsh anthracite (pea-size) can be obtained in most towns in the British Isles.

At any rate it is an incontrovertible fact that 1 B.H.P. can be obtained for an hour for 1 lb. of coal under ordinary circumstances, and for as little as $\frac{3}{4}$ lb. of coal under favourable circumstances.



Tangye "Suction" Producer Gas Plant.

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PRIME MOVERS COMPARED.

Compare the price of $\frac{1}{10}$d. per B.H.P. per hour for fuel with the fuel cost of other prime movers; and remember that this new system requires no more attention than an oil engine or a gas engine run from a town gas supply, so that it has, in common with these, a very great advantage over the steam engine in this respect.

An *electro motor*, with current supplied at 2d. per unit, will cost $1\frac{3}{4}$d. per B.H.P. per hour for current.

A *gas engine*, with gas at 4s. 2d. per 1,000 cubic feet (the gas having 600 British Thermal Units per cubic foot), will cost 1d. per B.H.P. per hour for gas.

An *oil engine*, with oil at 8d. per gallon, will cost 1d. per B.H.P. per hour for fuel oil.

A *steam engine* of the single cylinder type with ordinary slide-valve, non-condensing, with vertical boiler, will use from 10 to 20 lbs. of coal per B.H.P. per hour, according to the skill of the attendant and the regularity of the work.

A high-class compound condensing engine of from 50 to 150 B.H.P., with a high-class boiler and first-class attendance, will reduce the fuel account to 4 or $3\frac{1}{2}$ lbs. of coal per B.H.P. per hour.

The very best marine or stationary engine, with every refinement in the way of condensers, economisers, and superheaters, will not reduce the amount below 2 lbs. of the best Welsh coal per B.H.P. per hour.

SOME PARTICULARS OF THE NEW SYSTEM.

Suction producer gas plants have not hitherto been made of much larger sizes than 150 B.H.P. It is in the sizes from 10 B.H.P. to 100 B.H.P. that the advantages of the system will be principally felt. There is no very great economy of fuel in the large as compared with the smaller plants.

The cost of attendance is hard to reckon. In a factory where a man is already kept to do odd jobs to machinery the extra cost of attendance is *nil*, the charging of the furnace every three hours or so being all that is required.

It only takes 20 minutes to start the gas engine from the time a match is applied to the fuel in the generator.

The fuel in the generator will remain alight all night at an expenditure of only $\frac{1}{60}$ lb. per B.H.P. per hour.

MODE OF OPERATION.

To give a more detailed description of the gas-making process:—The Generator is a slow-combustion stove, through which steam and air are sucked by the "suction-stroke" of the gas engine.

The steam is made from water, contained in the top of the generator itself, which is evaporated by the hot gases rising from the

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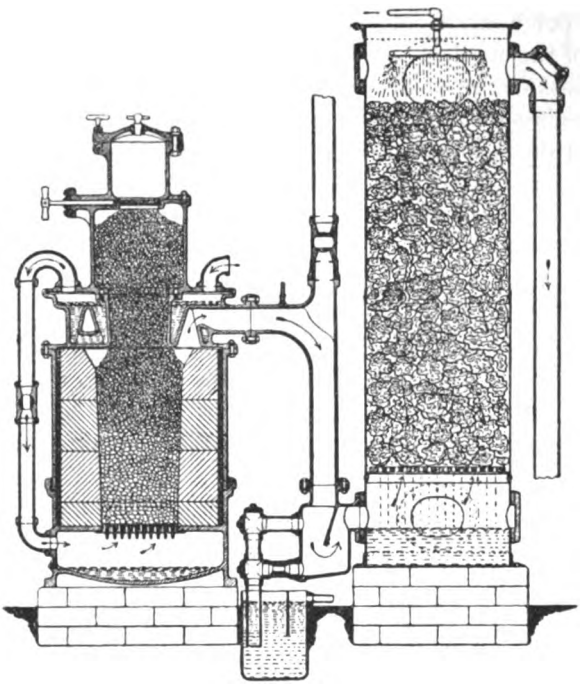
fuel. The air is drawn in over the surface of the water, and carries the steam (which is never under pressure) with it by means of a large external pipe from the top of the generator to the space below the grate.

The water evaporated is replaced by the dribble from a small tap, which should be regulated so that there is a slight overflow from the generator.

The coal is fed into the generator through a hopper on top.

The gas is drawn off and passes through a water-seal to the Scrubber, which may be described as a kind of filter, filled with coke, for the purpose of cleaning the gas of any matter which would be injurious in the cylinder of the engine; water is sprinkled continuously over the top of the coke.

Before the engine is started, a fan supplies forced draught through the fuel.



Sectional Elevation of the Tangye "Suction" Gas-Producer.

Anthracite coal or coke must be used in the generator just described; bituminous coal would form lumps of clinker and prevent the free passage of steam through the fuel, and there would have to be provided a considerable amount of apparatus to remove the tar from the gas. But where circumstances permit the erection of such extra apparatus, the tar forms a valuable bye-product and still further reduces the cost of the gas per B.H.P. per hour.

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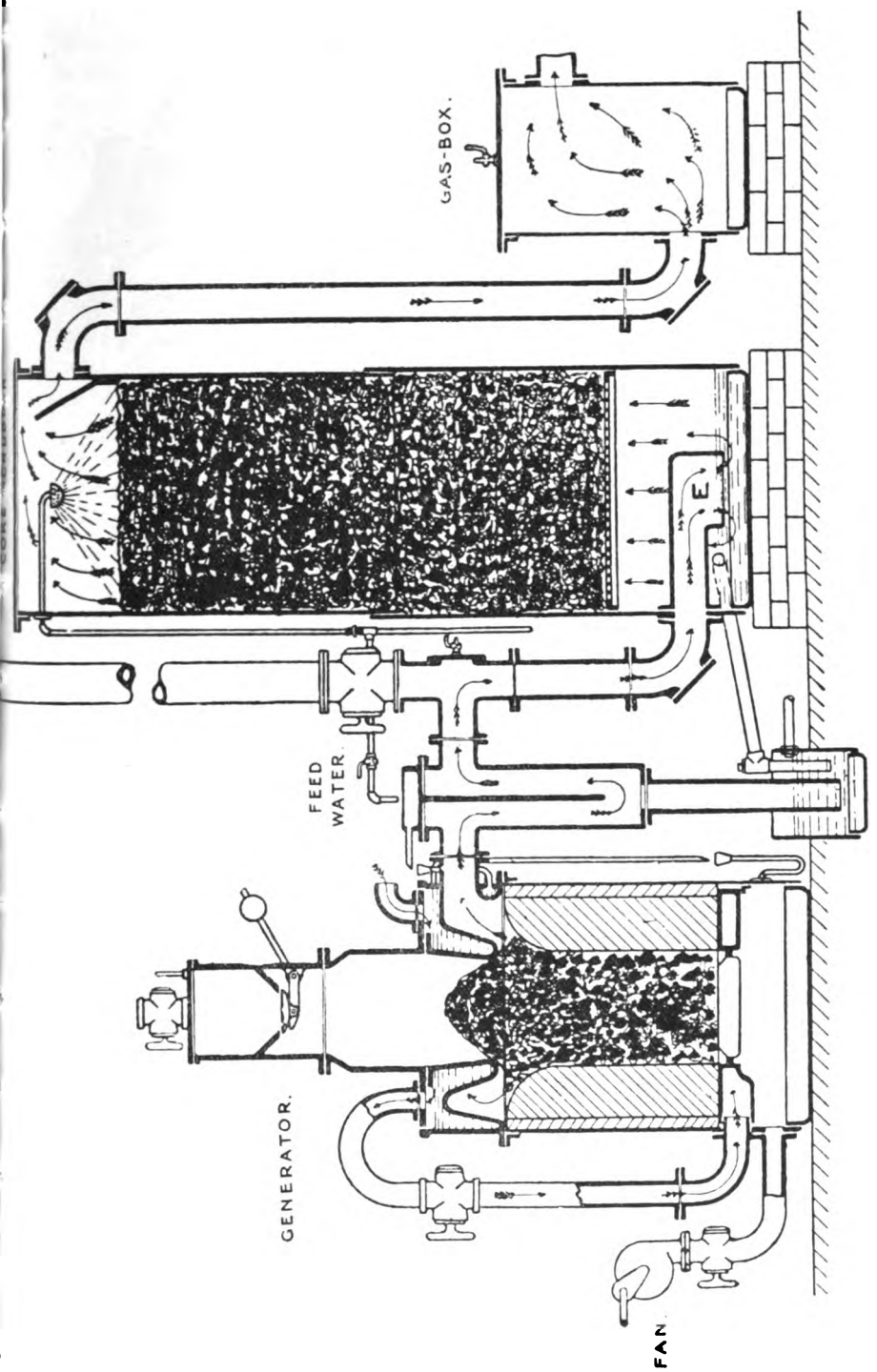

SECTIONAL ELEVATION OF "CAMPBELL" SUCTION GAS PRODUCER.

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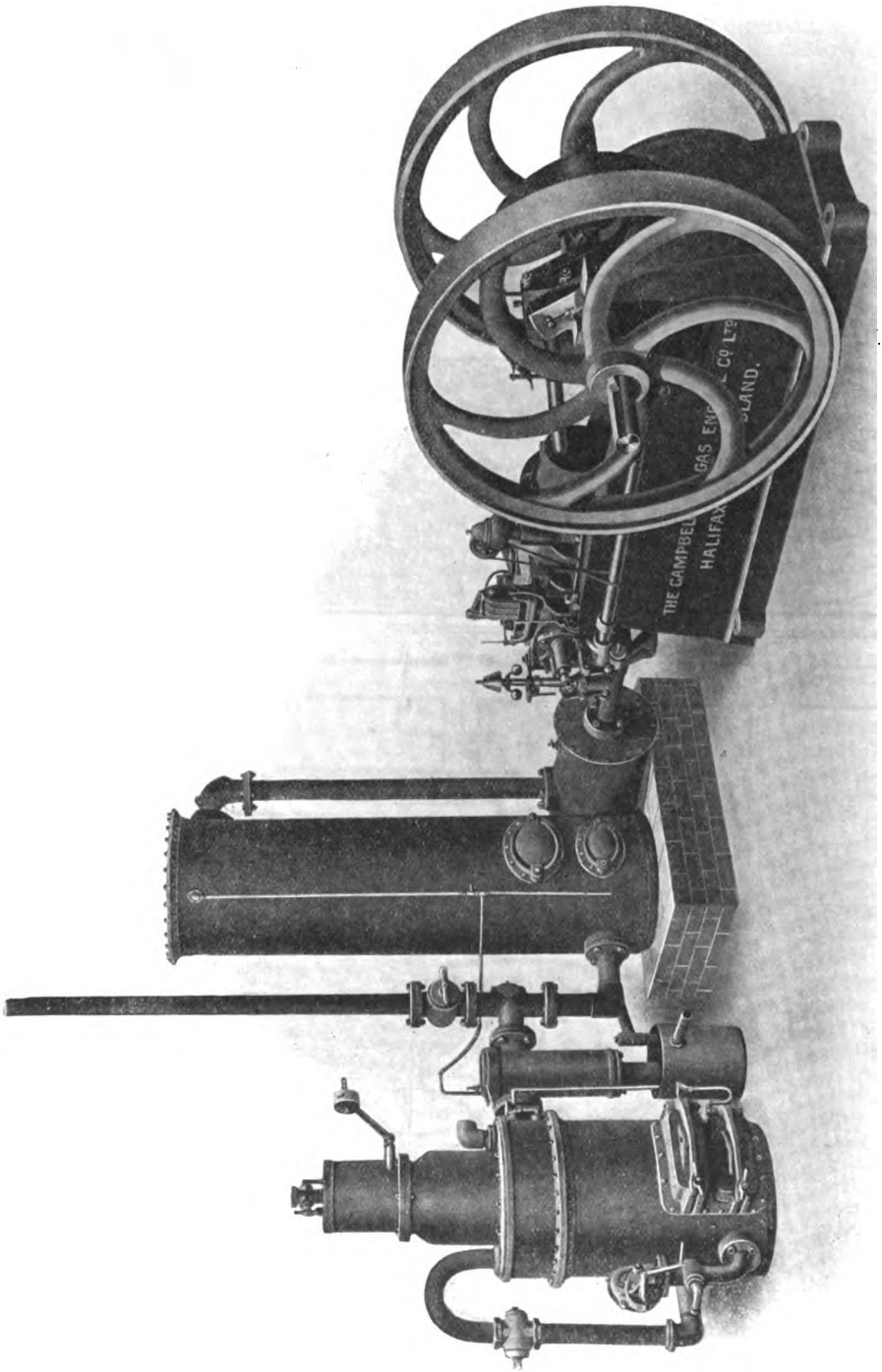

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Formerly the gas ("producer-gas," "water-gas," or "Dowson-gas") was made under pressure, which involved a large gas holder, a steam boiler, and other complications. The introduction of the automatic "suction" has enormously widened the field of usefulness.

PARTICULARS OF THE GAS MADE AND USED.

Now as to the composition of the gas. The oxygen in the air and water combines chemically with the carbon in the coal or coke, forming (principally) carbonic oxide and (partly) carbonic dioxide. The hydrogen in the water is set free and enriches the mixture. The nitrogen in the air is also set free, but—as also the carbon dioxide—possesses no "power" value.

The resultant gas has a calorific value of about 150 British Thermal Units per cubic foot, as against 550 to 700 B.T.U.s in coal gas supplied by town mains.

About four times as much producer gas as coal gas is required per B.H.P., but very little alteration is required in a gas engine to transform it from using towns' gas to using producer gas; in fact many engines are fitted so that they can be switched on to either by merely turning a cock.

FIELDS OF SPECIAL USEFULNESS.

For power production in factories, and for electric lighting of public institutions and barracks, this system has a great future before it.

I am indebted to Messrs. Tangye and the Campbell Gas Engine Co. for permission to reproduce the above illustrations.—T.E.N.

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THE DEVELOPMENT OF MORAL FORCES FOR WAR.

By Capt. C. H. Versturme-Bunbury, R.E.

In studying military history we find three main subjects to claim our attention :—firstly the facts; secondly the general principles of strategy and tactics, derived from a careful consideration of the facts; and thirdly, the more elusive and less palpable effects or phenomena that are referred to as "moral forces," and of which Napoleon has said that they are to the physical forces as three to one.

In our army at the present time the greatest care and attention is given to inculcating in all ranks the necessity of acquiring the habit of acting in accordance with sound principles. But can it fairly be claimed that we give the same attention to the cultivation of those moral forces that are undeniably of such immense value.

Colonel Henderson, in his *Battle of Spicheren*, says :—"Little less remarkable than the knowledge of their profession possessed by all, and the smoothness of the mechanism of the military system, is that spirit of confidence in themselves, their training, and their leaders, of loyalty to king and country, which pervades every rank of the Prussian Army.

"The soldier is treated as an intelligent being, a fit recipient of patriotic ideas and lofty sentiments. He is brought in contact with them from the day he joins the colours; and throughout his service his mental and moral training is considered as important as his physical."

And again, "To create a fruitful and abiding energy in both officers and men, the Prussian system of command, of training, and of decentralization was devised; and the deeper our study of military history, the surer grows our conviction that in so doing they acted in accordance with the greatest of the fundamental principles of war, and that to this quality, not to superior numbers or courage, their extraordinary success was due."

Hamley wrote :—"The world has seen before warlike people and victorious armies, but never before a people or an army who have sought the secret of success with study so thorough and with zeal and self-denial so stern as those which serve the German Emperor."

In many ways we have learnt and adapted much of the German system of army training; and there seems to be no reason why we should not now turn our attention to the development of those forces which give life and power to the principles that are so carefully taught.

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Many leaders have possessed the gift of infusing into their troops their own energy and moral power; but the Germans seem to be the first nation to have analyzed the sources of that gift and then to have deliberately cultivated it.

That this power is a real and substantial assistance to success in war there can be no question, and the wonderful victories of the Japanese in the late war in the Far East give another striking proof of its value.

The Japanese, like the Germans—and, possibly, to an even greater extent—seem to realize fully the vast importance of Moral Force, and to cultivate it most assiduously.

Colonel Henderson's words, quoted above, seem to indicate the secret of and the proper method of developing this Force. "The soldier is treated as an intelligent being, a fit recipient of patriotic ideas and lofty sentiments; and throughout his service his mental and moral training is considered as important as his physical."

The introduction of Colonel Henderson's *Stonewall Jackson* as a text-book for examinations for promotion appeared to mark on the part of the authorities an appreciation of the value of Moral Force, for no book could be chosen in which this is more insisted upon or more clearly displayed.

Why should not some system be arranged for lectures to be given to all ranks, with readings from the stories of our own and other great wars and victories. By such means these Moral Forces would be developed; while at the same time fresh interest would be aroused in our manuals and text-books, in which the principles of Strategy and Tactics are laid down, but which, from their very nature, are bound to be somewhat dry and difficult to absorb.

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MEMOIR.

Lt.-Col. H. Wilberforce Clarke, R.E.

There has recently passed away one of the most brilliant and versatile of the many good men turned out from the H.E.I.C.'s Military Seminary at Addiscombe.

Henry Wilberforce Clarke, the subject of this memoir, was born in 1840, educated at Cheltenham College, and finally at Addiscombe (1858—1860), which he left, second of his "batch" (the last batch of the old Indian Engineers), as a lieutenant in the old Bengal Engineers (8th June, 1860).

After the usual time under instruction at Chatham, he went out to India in October, 1862, and in May, 1863, joined the Indian Public Works Department, wherein he soon made his mark. A fine career in the P.W.D. might now have been expected for him. Unfortunately his health broke down early (in 1865); and this, with subsequent attacks, necessitated prolonged sick leave to Europe (1865–66, 1869–72, 1880–84), and thus broke up his continuous service in India, and prevented his ever rising to the higher posts of the Department.

Whilst in India he held at times some very good posts, *e.g.*, Assistant to Chief Engineer and Assistant Secretary to Government in P.W.D. in 1865, and again in 1868–69; Deputy Consulting Engineer for Railways, 1876–80 and 1888–89, and Consulting Engineer, 1890.

His sick leaves to Europe led, however, to his seeing a varied service, both in the field and otherwise, in parts of the world not usually open to the old Indian Engineer. Thus he was Assistant Field Engineer with the Abyssinian Expedition (1867–68), was mentioned in despatches for "excellent service," and obtained the medal. After exchanging to home service in 1882, he was selected to project the Suakin-Berber Railway (1884); served as Director of Railways in Egypt in 1884; and was an A.A.G. with the Nile Expedition (1884–85), with which he advanced as far as Dongola, being subsequently mentioned in despatches and receiving the medal with clasp and star. After this he became C.R.E. at Devonport (1885–86), and was C.R.E. in S. Africa, 1886–88. After a further short period of service in India, as Consulting Engineer for Railways (1890–91), he retired in 1891 as a Lieut.-Colonel.

After some years travel abroad he settled down on the small property of Dilkusha, of about 100 acres, at Sestri Levante in

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Liguria, favourable to the growth of the olive, vine, orange, fig, etc., and busied himself thereafter in the improvement of their cultivation. He died there of heart complaint on the 5th October, 1905. He was twice married (first in 1872, again in 1897). By the first wife, who died in 1893, he leaves two sons and two daughters. His second wife survives, and contributes most of the materials for this short biography. The two sons are still engaged in the improvement of their father's estate.

Two instances of Clarke's versatility may be given. He was selected from those on the Nile Expedition (1884) to determine the latitude and longitude of certain positions in the Nile valley, a work which would be assigned in India to the staff of the Indian Survey. Again, he had a strong taste for languages, so much so that—in spite of prolonged absences from India—he became a competent Persian scholar, and was selected by the Bengal Asiatic Society as translator of part of the *'Ain-i-Akbari*, and was even a candidate for the chair of Persian at Oxford, 1880. He published, among other works, the following :—A "Persian Manual" (1878), which was adopted by Government for the Indo-European Telegraph Staff. Translations into English prose of four of the great Persian poems :—1. The *Bústán* of Sadi (1879); 2. The *Sikandar Náma-e-Nizámi* (1881), 800 pp.; 3. The *Díwán-i-Háfiz* (1891), 2 vols.; 4. The *Sháh-Náma-e-Firdausi*, 2,000 pp. These volumes have received the warm appreciation of many scholars (including the late Sir H. Rawlinson, Sir Monier Williams, and Prof. Max Müller), and form a lasting monument of the author's talents and industry.

It remains to record some personal traits. Clarke was rather short of stature, and of a genial though somewhat combative disposition ; a warm friend, and a good hitter-out (especially in writing) at an adversary. He was familiarly known among his intimates by the "pet" name of "Boxer," and accordingly sometimes passed as "Mr. Boxer" among those who only knew him by this style ; thus he was habitually called "Mr. Boxer" by the old tar (familiarly known as "Ben") in charge of the R.E. Boat Club boats (1860–62), much to the amusement of Clarke's companions. Clarke was very popular among the younger officers when he had himself become a senior. An amusing instance of this occurred after a big dinner at the Chatham Mess. After dinner was over (and the seniors had all left the table) there arose a call among the juniors present that Clarke should take the chair and deliver a speech (he being a good *raconteur*, and a humorous after-dinner speaker) ; as he was about to take his seat, the chair disappeared, and the would-be occupant subsided on the floor to find himself smothered in a shower of rose leaves !

ALLAN CUNNINGHAM,
Lt.-Col., late R.E. (Bengal).

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TRANSCRIPTS.

THE JHELUM RIVER HYDRO-ELECTRIC POWER INSTALLATION IN BRITISH INDIA.*

THE Government of British India has for some time pursued a broad-minded policy in developing the later possibilities of the immense and valuable country over which it exercises sovereignty, and its officials have interested themselves in providing for the future welfare and enlightenment of the native inhabitants. Among other laudable projects, which the Government has instituted, has been the commissioning of some of the most capable Royal Engineers to plan for and construct public works, such as would aid in the general advancement of the native industries and the development of the commerce of the country.

The first notable project undertaken for the generation and distribution of electricity was that of the Cauvery power scheme, located in Mysore State in Southern India. Work on this plant was started in 1900, the initial installation being completed, after many difficulties, in June, 1902. About a year ago, the second installation or extension of the plant, consisting of 3,610 kilowatts generator capacity, was completed. This increased the possible output of the entire plant to 7,920 kilowatts, making it the largest hydro-electric installation now operating in Southern Asia, if not on the entire Continent.

The chief credit for the completion of the Cauvery power plant is due to Major A. Joly de Lotbinière, R.E., deputy chief engineer of the Government of Mysore, who not only conceived the plan of the installation, but successfully arranged for the financing of the entire project, overcoming prejudices that would have deterred a man less sound in his convictions. He afterwards arranged for the purchase of the entire electrical and hydraulic equipment and supervised its installation.

The power scheme next to be undertaken is the Jhelum power installation on the Jhelum River, in Kashmir in North-West India. This power plant is to be installed near Rampur, about 50 miles below Srinagar, where a six-mile conduit will give a head of water at the plant of about 400 ft. The present plans call for an installation of about 20,000 horse-power.

It is planned to use the power for operating the Kashmir section of the Jhelum Valley Railway electrically along its entire length of 180 miles. A single-phase system of traction will undoubtedly be installed. Possibly the most important immediate use to which the power will be put will be

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in operating dredgers for the purpose of deepening the Jhelum River in the Kashmir Valley, and thus minimising the floods which, under existing circumstances, periodically devastate the entire country. The contemplated plant will also allow of the reclamation of a very large tract of land; and permit of the storage of water in Wular Lake, above the power plant, for sale to the Punjab Irrigation Department. Another important use of the power will be for operating the large silk factory at Srinagar, and also for supplying with current the electrical water-heaters in the silk mill. In addition, the power will be utilised for other industrial purposes, and for lighting in Srinagar and in Abbotabad, Murree, and Rawal Pindi, prosperous towns in the British provinces adjoining Kashmir.

After successfully completing the preliminary arrangement for carrying on the important work connected with the Jhelum power installation, Major de Lotbinière was instructed last May, by the Jammu and Kashmir State Council, acting for the Maharajah of Jammu and Kashmir, to proceed to Europe and America in order to interview the leading hydraulic and electrical manufacturers, and to ask those selected to bid upon the machinery and materials for the plant. Carrying out these instructions, he visited the works of those leading manufacturers on both continents who were considered for the work, and personally inspected their manufacturing establishments, as well as power plants in which their machinery was operating.

As a result of this careful investigation, Major de Lotbinière, who had full powers for the acceptance of the tenders submitted, has recommended to his Government that the contracts for the entire hydraulic and electrical equipment be placed with firms in the United States. The contract for the hydraulic equipment was awarded to the Abner Doble Company, of San Francisco, U.S.A., and calls for the hydraulic plant complete from the forebay to the tailrace, including the intake, valves, pressure pipes, pressure pipe thrust-blocks, interior piping, water-wheels and nozzles, hydraulic governors, and all details necessary for the hydraulic equipment. The apparatus and materials are to be delivered at the port of Karachi, India.

The gravity conduit line for the power plant will be approximately 34,000 ft. in length, and for the upper 8,500 ft. will consist of an excavated ditch lined with masonry. The remaining portion of the water channel will consist of a rectangular flume, or a wooden stave pipe, such as has been installed so successfully in connection with plants of this character on the Pacific coast. The flume will have a capacity of over 500 cubic feet per second. The forebay at the end of the gravity line and at the head of the pressure pipes will be constructed of masonry, and will be provided with special head-gates. The sliding elements of the intake gates will be of timber, all iron and metal parts necessary for the construction of the gates being furnished by the hydraulic contractor.

The pressure lines will consist of riveted steel pipes designed with a factor of safety of five, each supplying one of the hydro-electric units. For each pipe-line a stand-pipe and two special vacuum valves will be provided, in order to protect the pipe against injury in case the water should be drawn out suddenly.

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At the lower end of each pressure line the last length of pipe will terminate in a flange, which will be bolted to a massive cast-iron thrust-block that will rest on a heavy cast-iron sole-plate or base. The latter will be mounted on a substantial masonry foundation and held in position by anchor-bolts. This fitting will be designed to take the entire hydraulic thrust of the pipe, an ample factor of safety being allowed, so that under the most severe conditions there will be no strain on the branch piping in the interior of the power-house. Each pressure line will consist of a riveted steel pipe, varying in diameter from 30 in. to 36 in., and a 54-in. to 36-in. taper pipe, 10 ft. long, at the upper end. The pipes will be 790 ft. in length, and will deliver the water under an effective head of 400 ft.

The interior piping of the power-house will consist of welded pipe with welded flanges, all piping and fittings beyond the thrust-block being designed with a factor of safety of 10, and subjected to a test pressure of 1½ times the working pressure for a period of five hours.

Twelve main units and three exciter units have been planned for the equipment of the power-house. Each main unit will consist of a Doble tangential water-wheel, with automatic oil-pressure governor, delivering 1,765 brake horse-power to the shaft, under an effective head of 400 ft. Each wheel will be direct connected to a 1,000-kilowatt alternator, the speed of the unit being 500 revolutions per minute. The exciter units will each consist of a Doble tangential water-wheel delivering 285 brake horse-power to the shaft, under an effective head of 400 ft. The speed of the exciters will also be 500 revolutions per minute.

The hydro-electric units will be of the Doble standard two-bearing type, the wheel-runner being fastened on the end of the shaft. For each of the main units the Doble Company will furnish a high carbon open-hearth-steel forged shaft, and two bearings of a special ring-oiling type, provided with revolvable bearing shells. The exciter water-wheel runners will be mounted on the extended ends of the exciter generator shafts.

The water-wheels will be equipped with ellipsoidal buckets, needle regulating-nozzles, and centrifugal water-guards. The regulation of the main units will be effected by means of hydraulic governors operating jet-deflectors. For the exciter units hand regulation will be provided by means of the needle nozzles. The gate-valves for each wheel will be of special construction, with outside screw and yoke, bronze mounted, with by-pass.

The power-house will be of solid masonry construction, and will have a wide verandah as a protection from the tropical sun. A double steel roof will be provided, and two travelling-cranes will be installed for handling the machinery. The transformers will be installed in a bay of the main building or in a separate structure.

The conditions under which the plant will be installed are decidedly out of the ordinary, as compared with similar work in this country. The specifications for the electrical and hydraulic equipment stipulated that no single piece of machinery should weigh more than 4 tons when packed, for the reason that there is 200 miles of road transportation, including a lift over a range of mountains 8,000 ft. high. Transportation

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in that section of the country is limited to bullock-cart; and no single piece of machinery heavier than 4 tons can be transported, a total of 5 tons, including the trolley (cart), being the maximum weight that can be hauled over the mountains.

Portland cement costs 7·50 dols. per barrel delivered at the site, making its use prohibitive for heavy concrete work. However, there is plenty of natural rock in the vicinity, so masonry construction will be used for the walls of the power house and for the foundations of machines, intake, forebay, etc.

The entire hydro-electric installation will be constructed, erected, tested, and placed in operation under the supervision of Major A. Joly de Lotbinière, R.E. Major H. A. D. Fraser, R.E., and Capt. W. M. Thompson, R.E., will act as his engineering representatives in London. Mr. A. C. Jewett, formerly of the General Electric Company, will serve as installing engineer for the Government. Mr. Jewett was connected with the installation of the Cauvery plant, and his selection as erecting engineer for the Jhelum River installation comes as a well-deserved recognition of his ability.

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BULLET-PROOF SHIELDS.*

WAR is becoming more and more an engineering undertaking that must be conducted—to be conducted successfully—on engineering lines. There is no less demand for personal valour than there used to be; perhaps even there is more; but the ever-increasing deadliness of modern weapons tends continually to narrow down the line of separation between heroism and folly.

One man who cuts away a wire entanglement under cover of a shield is of more service to his country than a hundred who lay down their lives in the vain attempt to do it without one. The serious consideration of shields as part of the regular equipment of an army in the field has hitherto been hindered by two objections, one sentimental, the other material. Sentiment is surely a little out of place in matters affecting the position, sometimes even the existence, of nations. The recent fearful losses of the Japanese in attacking the Russian entrenched positions in Manchuria show the absolute necessity for some portable cover for the attackers if they are to have a chance of success. The Japanese themselves found this out after paying thousands of lives for the experience, and in the later stages of the siege of Port Arthur they appear to have extemporised more or less efficient shields out of such plates as were available. The material objection is principally that of adding to the weight of what the soldier has to carry, hampering his movements, and detracting from his mobility. This would be a serious objection as against a shield forming part of the soldier's personal equipment; but it does not apply to shields taken to the front in case of emergency—kept, say, with the reserve ammunition, unless and until an occasion for their use arises, such as the attack of a carefully-prepared entrenched position principally defended by infantry fire. In such a case suitable shields properly used should go further towards equalising the attack with the defence than a four-to-one numerical superiority. Shields of some kind will have to be used if the attackers are to be kept alive while they destroy the obstacles which, by preventing them from advancing quickly, give the defenders time to prevent them advancing at all.

Of course there would be cases where shields would be useless—where the ground was well covered by artillery fire, for instance; but the fact that they were kept in readiness to the attackers' hands would be of no small value, if it did no more than compel the defence to always provide artillery fire when otherwise infantry fire would suffice. Numerous cases occur in every campaign—witness our loss of guns at Colenso—when serious disaster might be averted or important advantage gained, if only the means were at hand to enable a proportion at least of a detachment to advance over, and retire unscathed from, a musketry-swept area.

* *From an article by Capt. T. J. Tresidder, C.M.G., late R.E., in Brassey's "Naval Annual," 1905.*

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RESISTANCE AND WEIGHT OF BULLET-PROOF STEEL.

The special steel now manufactured for the purpose is stated by Messrs. Cammell, Laird & Co., who make a speciality of the material, to be proof as under:—

Against	Mauser or Mannlicher rifles at	20	yards	...	$\frac{1}{4}$	inch,
,,	Lee-Metford or Lee-Enfield at	200	,,	...	$\frac{3}{16}$	,,
,,	,,	300	,,	...	$\frac{1}{8}$	,,
,,	,,	500	,,	...	$\frac{1}{16}$	,,
,,	,,	700	,,	...	$\frac{1}{16}$	,,

that is for normal impact; against oblique impact the efficiency of each thickness would be greater.

The approximate weights for these thicknesses per super. foot are respectively 10 lbs. 4 ozs., 7 lbs. 11 ozs., 5 lbs. 2 ozs., 4 lbs. 1½ ozs., and 2 lbs. 9 ozs.; so that it should not be difficult to design very efficient shields of a sufficiently portable nature. It would be not so much perhaps the main attacking party who would use them, as their pioneers, who, under cover of them, would destroy or neutralise the obstacles constructed by the defenders to check a rush.

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THE NEW GERMAN RIFLE BULLET.*

Two of the most important properties which a military rifle can possess are great ranging power and a flat trajectory.

These properties depend mainly on two factors, high muzzle velocity and high sectional density, *i.e.*, a high ratio between weight and cross section of bullet. A third factor is the shape of the bullet, more particularly the shape of the head, by which the resistance of the air is considerably modified.

Considerations of recoil, weight of rifle, etc., make a heavy bullet incompatible with high muzzle velocity; and in order to keep the sectional density as high as possible, it has been found necessary, as the evolution of the rifle has progressed, to reduce the diameter of the bullet as well as to reduce its weight. In modern military rifles the diameter of the bullet varies between 0·32 and 0·26 inches, the corresponding weight of bullet being from 244 to 163 grains.

The German military authorities have been experimenting for some time past with a view to increasing the muzzle velocity of their rifle to approximately 3,000 feet per second, in order to insure the flattest possible trajectory at decisive ranges, a consideration which they regard as of primary importance.

There were obvious objections to doing this by reducing the calibre of their rifle from 0·311 to 0·256 (or some smaller calibre), which would be the first method to suggest itself. Apart from the great cost involved in such a change, there are certain objections to a very small bore, *per se*, viz., diminished wounding power and increased difficulty of cleaning and keeping in order the interior of the barrel.

The alternative solution was to improve the ballistics of the existing rifle by a suitable modification of its ammunition; and it appears, from a recent article in the *Kriegstechnische Zeitschrift* (1905, *Heft* 9), that this has been effected partly by the adoption of a more powerful charge (whether a new powder is involved is not quite clear) but mainly by the adoption of a new bullet, known, on account of its pointed shape, as the Spitzegeschoss or "S" bullet.

This bullet (a sketch of the reported shape of which, together with further details, is appended) weighs only 154·3 grains as against the 227 grains of its predecessor, or as against the 215 grains of our Lee-Enfield bullet.

This reduction of 73 grains weight, coupled with the higher pressure given by the new charge, has apparently raised the muzzle velocity of the German Mauser from about 2090 f.s. to about 2900 f.s.

* *Communicated.*

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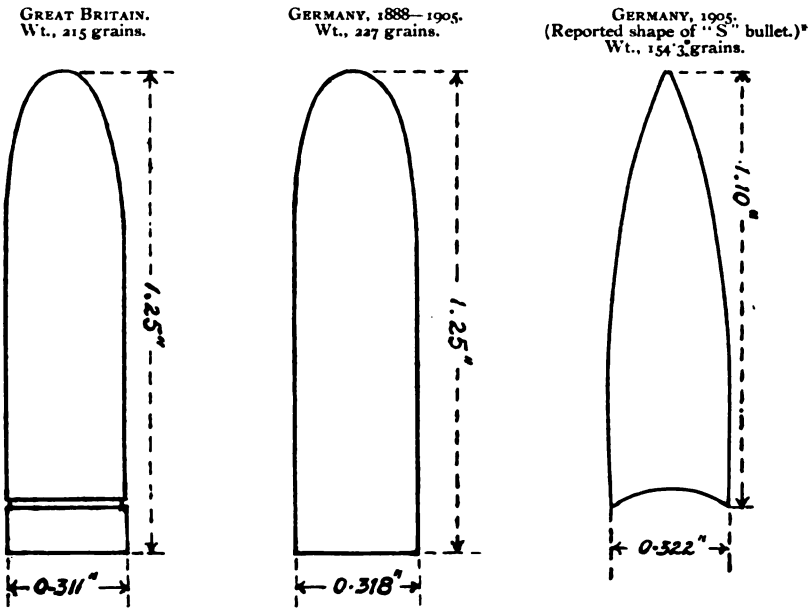
An additional, and by no means unimportant, advantage secured by the reduction in weight of the bullet is that about 15 per cent. more ammunition can be carried than heretofore.

BRITISH AND GERMAN RIFLE BULLETS.

Scale ⅔.



All three bullets have lead cores, the British bullet having a cupro-nickel jacket, the jackets of the two German bullets being of nickel-plated steel.

* *Kriegstechnische Zeitschrift* (Heft 10, p. 607).

It will be seen that in designing their new bullet the Germans have deliberately departed from the principle, hitherto considered essential, of a high sectional density.

Assuming, however, the correctness of the published data, it is evident that this low sectional density has been compensated for by the altered shape of the new German bullet, which gives rise to a very much lower air resistance than has hitherto been considered possible at normal atmospheric temperature and pressure.

The importance of the alteration in form may be gauged by the fact that, had the normal shape been retained, the remaining velocity of the bullet at about 1,000 yards would have been no greater than that of our bullet, which starts at 800 f.s. lower velocity, while beyond 1,000 yards the heavier bullet would have travelled faster.

As it is, the "S" bullet maintains its superiority in velocity at practically all ranges. Whether it compares favourably with the heavier bullet in accuracy is, however, doubtful.

The greatest advantage given by the "S" bullet in the matter of flatness of trajectory is to be found between 500 and 800 yards. At 700 yards

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range a man 5 feet 9 inches in height would be hit anywhere along the range, if the muzzle of the rifle were 12 inches from the ground, the sight set at 700 yards, and the ground line aimed at. The same effect would only be produced with our present Service rifle at about 550 yards.

Without experimental data it is difficult to estimate exactly the energy of recoil of a 9-lb. rifle with a muzzle velocity of 2,900 f.s. and a 154-grain bullet, but it would appear to be well below the limit of 15 ft.-lb., which is the maximum desirable in a military rifle.

Two further questions affecting the military value of the new bullet arise: its wounding power, and its penetration.

Taking the striking energy of the bullet as the measure of its wounding power, it would seem that the new bullet is more effective than the Lee-Enfield up to between 900 and 1,000 yards; beyond that range it is slightly inferior, but the difference is not marked.

Apart from its superior striking energy, however, the so-called explosive effect, characteristic of modern high-velocity bullets at close ranges, would probably be occasioned by the "S" bullet at very much greater ranges than is at present the case; possibly up to 600 or 700 yards, as against 200 or 300 with the present bullet. Experiments, however, would be necessary to test this point.

As regards penetration, the advantage must lie with the new bullet at all except extreme ranges.

Diagrams of the new and old German bullets, and of our 0·303 bullet, together with comparative ballistic tables and diagrams of trajectories, are appended.

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RANGE TABLES.*

Lee-Enfield. "C"=0·411. "S" Bullet. "C"=0·40.

Range.	Angle of Projection.				Time of Flight.		Remaining Velocity.		Striking Energy.		Maximum Height Attained.		Angle of Descent.			
	L.E.		"S."		L.E.	"S."	L.E.	"S."	L.E.	"S."	L.E.	"S."	L.E.		"S."	
yards.	degs.	mins.	degs.	mins.	secs.	secs.	ft.-secs.	ft.-secs.	ft.-lbs.	ft.-lbs.	feet.	feet.	degs.	mins.	degs.	mins.
0	0	0	0	0	0	0	2060	2959	2036	2916	0	0	0	0	0	0
200		9		4½	0·32	0·23	1673	2355	1343	1910	0·4	0·2		11		5
400		21		10¼	0·72	0·52	1361	1900	889	1244	2·1	1·1		28		14½
500		29		14¼	0·95	0·68	1229	1712	724	1009	3·6	1·9		40		21
600		37½		18½	1·21	0·87	1119	1538	600	814	5·8	3·0		55		28½
800		59		29¾	1·78	1·30	981	1239	461	529	13·3	6·8	1	36		53
1,000	1	25		45¼	2·43	1·83	886	1039	377	371	24·9	14·0	2	25	1	30
1,200	1	58	1	5½	3·14	2·44	807	930	313	298	42·2	25·2	3	26	2	19
1,500	2	56½	1	46	4·33	3·50	708	803	240	222	83·5	53·5	5	22	3	53
2,000	5	8	3	21½	6·70	5·60	569	642	155	142	198·0	141·0	9	56	7	39

* The "S" table has been calculated upon the basis of the article in the *Kriegstechnische Zeitschrift*.
Similar tables, based upon slightly different data, have appeared in the *Field* of the 16th December last and in the January number of *Arms and Explosives*.

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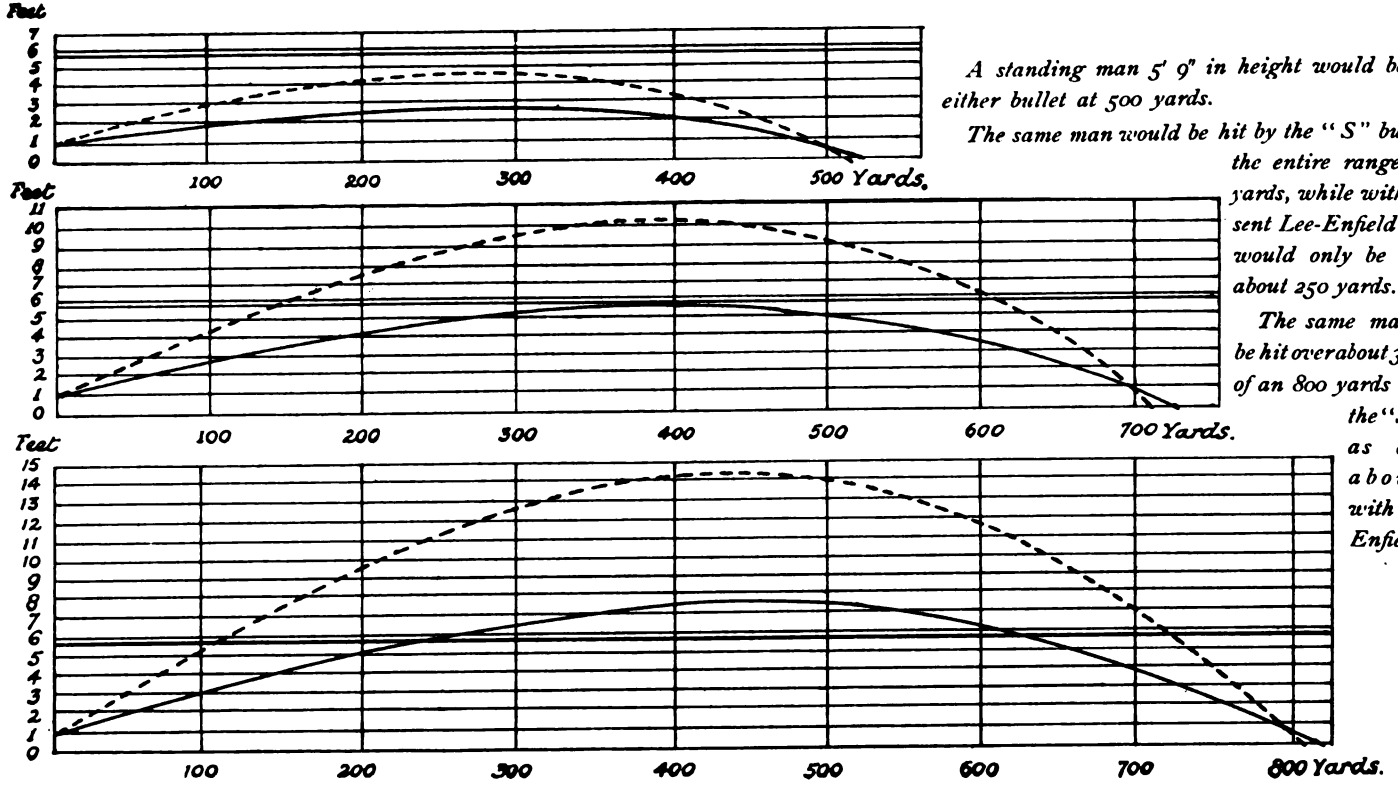
TRAJECTORIES OF LEE-ENFIELD AND "S" BULLETS AT 500, 700 & 800 YARDS, MUZZLES 1 FT. FROM GROUND.

L.E. (upper) - - - - - . "S" (lower) ——— .



A standing man 5' 9" in height would be hit by either bullet at 500 yards.

The same man would be hit by the "S" bullet over the entire range of 700 yards, while with the present Lee-Enfield bullet he would only be hit over about 250 yards.

The same man would be hit over about 350 yards of an 800 yards range by the "S" bullet as against about 180 with the Lee-Enfield.

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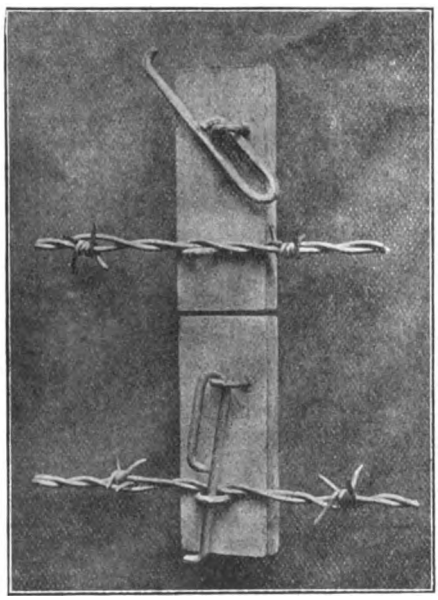
PATENT "THOROUGHPIN" FENCING WIRE ATTACHMENT.*

FARMERS and others have often occasion to need some simple and inexpensive method of fixing fencing wire so that it may be at any time expeditiously lowered and put up again. This want is especially felt during the hunting season and in the shifting of game and poultry runs, and at many other times.

The invention here illustrated consists of a wire pin of (perhaps) two inches in length, looped at one end to about half its length, and slightly bent over at the other end, as in the drawing showing it unfastened. The looped or upper end is attached to the post by a staple, and a similar staple is fixed lower down to receive the free end of the pin. The wire is stretched close to the post slightly above the lower staple, through which the pin is then passed, and remains down by the gravity of its own weight, as shown in the second sketch. It can then be quickly released when desired, but will not come accidentally unfastened, nor will it be affected by cattle.



The attachment is simplicity itself, there are no loose parts, and its cost is trifling. Intended for barbed wire primarily, the "Thoroughpin"

* Reprinted by permission from *Patents* of May, 1905.

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is equally suitable for plain or any wire. With barbed wire it also serves admirably when it is desired to join two lengths, as the pin will carry two thicknesses of wire equally well; and if the two ends to be joined are cut near the barbs and fastened under the pin, the claws drawing in opposite directions will catch in it and be held securely.

The invention is the idea of Mr. C. F. Howland, Thame, Oxfordshire, who is himself a practical farmer, and fully understands the requirements of the case.

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REVIEWS.

AMERICAN REPORTS ON MILITARY OPERATIONS IN SOUTH AFRICA AND CHINA.

(U.S.A. War Department, Washington).

This is a bulky volume, containing the reports of the United States Military attachés on the South African War, and also reports made by American officers on the operations that led to the relief of Pekin and the crushing of the Boxer rising. In addition, there is a lengthy summary of the various operations, so that in many cases two accounts are given of the same incidents. The volume, therefore, does not provide as much information as its outward appearance promises. It further shows signs of careful editing, and the reader is sometimes tantalised with a row of asterisks, at the very moment when he thinks he is about to come upon some information of unusual interest.

The historical value of the work is not very great, because the attachés were not present at any of the operations previous to Paardeburg, nor did they see any of the fighting in Natal. The absence of any large scale map of Tientsin and the surrounding country renders the accounts of the various actions that took place in its vicinity quite unintelligible to anyone who is not acquainted with the locality. The account of the operations in China is inferior to that issued by our War Office; but the latter unfortunately is confidential.

However, the very generous and friendly criticism of our troops and their doings renders the book a pleasant one to read, and the comments on the various operations are extremely valuable. The gist of the criticisms that are scattered through the book is given in the following extracts:—

The South African War, 1899—1902.

British Strategy in South Africa.

The failure of the Natal force to co-operate with Lord Roberts' army is the only part of our strategy that is criticized. "Had even a portion of the Natal force entered the Free State through the almost unguarded passes, and operated in conjunction with Lord Roberts' army from Bethlehem north, the result would have been decisive and conclusive."

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British Tactics.

The general impression conveyed by the criticisms of the various operations is that the British tactics were often unnecessarily aggressive. Frontal attacks were sometimes pushed home before the flanking columns could make their presence felt, the battle of Driefontein being quoted as a special instance. The attaché with the Boers considered that the thin firing lines employed by the British failed to give them the necessary superiority in fire effect.

British Organization.

There are practically no comments on the British organization, so it was presumably considered suitable.

British Personnel.

The rank and file are lavishly praised. "They have not the individuality and resources of our men, but for indomitable courage, uncomplaining fortitude, and implicit obedience they are beyond criticism."

The officers, however, did not win such unstinted admiration. "The majority of the British officers look upon their army service as a mere incident in their lives, shortly to be given up for the delights of country and town life; few of them make themselves proficient in those innumerable details necessary for a professional soldier to know, and rely too much, far too much, on the non-commissioned officers to assume those duties which rightly and properly they themselves should perform."

It will be remembered that about the time these reports were written the English newspapers were full of similar criticisms; they were probably truer when they were written than they are now.

British Cavalry.

It was noticed that the British cavalry had not been sufficiently trained in dismounted work, and the American cavalry are held up as a model. "Our cavalry, combining as it does the essential advantages of both mounted infantry and cavalry, renders unnecessary the two distinct branches, but it should have a gun firing a larger bullet, for the ·303 bullet will not stop a horse."

"The saber scabbards of the British cavalry were lined with wood or cork, and a keen edge was kept on the blade for some time. They are really a cutting weapon, not merely a steel club as ours must always be with nothing inside the scabbard to protect the edge."

Cavalry armed with steel clubs cannot be said to possess all the essential advantages of that arm. It was observed in China that the American cavalry preferred to use their pistols to their sabres, and several of our cavalry officers expressed doubts as to whether the men had been taught to consider shock tactics as part of their proper *rôle*. They lacked, in fact, just those qualities that should distinguish cavalry from mounted infantry.

British Artillery.

"The artillery has shown itself in my opinion to be the best branch of the combatant service. The field and horse artillery guns were not of the most modern type, and were very often outranged by the enemy's; nevertheless the gunners, both officers and men, have demonstrated that they are as good as the most critical commander could desire."

The attaché with the Boers writes:—"The British artillery always strongly supported the attacking infantry, and kept up its fire to the last minute."

The effect of the heavy guns was more moral than physical.

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"The balloon with the British army has been of unestimable value to it. It usually ascended about 2,500 yards from the enemy's line and secured valuable information especially for the artillery." British Engineers.

"The field telegraph has been admirable."

"The railway engineering work was always splendidly done, both by the Royal Engineers and Volunteers (railway pioneer regiment). To them is mainly due the possibility of the rapid advance of the army to Pretoria, for without the railway the army could move only slowly, and every bridge and almost all the culverts were blown up between Karree Siding and the Vaal River, and in some places the road bed and rails."

The attachés had no opportunity of seeing any of the work of the Bridging Companies.

"The infantry has done splendidly always, but the reluctance of the soldier to intrench himself, and the indifference of the officers to enforce this most necessary and vital precaution was strikingly shewn upon all occasions. They would pile up a little parapet of stones visible for a long distance but they would rarely ever dig a trench." British Infantry.

"It has worked during this difficult campaign most admirably. The same officer in collecting supplies, collects the transport to haul them and makes all arrangements for their shipment, thus obviating friction, confusion, and unnecessary delay. I consider the Army Service Corps one of the best things I have seen in the British army." Army Service Corps.

"The medical service, hospitals, and all pertaining thereto were generally admirable. There was naturally much overcrowding in the stationary and general hospitals, due to the exceptionally large number of enteric patients. Among the field ambulances were some sent from India, called dhanjibhoys,* very light and mobile, and they did excellent work in quickly transporting the wounded and sick." Medical Arrangements

The attaché with the Boers estimates that they never had more than 35,000 men in the field at any one time. The Boer Strength.

The great error committed by the Boers was their failure to invade Cape Colony at the beginning of the war. This course was advocated by all the younger commanders, but was vetoed by General Joubert. The latter thought the war would consist of some fighting on the Natal border and nothing more. Boer Strategy.

The Boer tactics are too well-known to require much comment. "As a rule his lack of offensive capacity prevented the Boer from reaping the fruits of tactical victory. He was contented when he had repulsed the enemy." Boer Tactics.

"When offensive operations were undertaken, the foreigners had to bear the brunt of the fighting."

The Boer discipline was very bad. The system under which a commando elected its own officers was radically wrong and its effects disastrous. "There were laws in existence to enforce discipline, but the government had made the mistake of not enforcing them from the beginning, when things were going favourably, and did not dare to change its policy when things were going the other way. To the Boer Discipline.

* Thus is immortalised the name of the munificent donor of the ambulance tongas.—J.E.C.

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military mind the degree to which inferior officers carried their self-will is unconceivable."

"More than once General Botha and others agreed in conversation that the only force fit to make war with was one composed of men regularly trained and disciplined by barrack life and regularly paid."

When this fact is recognised in England, the re-organization of our military resources should be a comparatively easy matter.

Boer Intrenchments.

The American attachés did not admire the Boer trenches. "Their trail resembled a writhing snake which lessened the danger of enfilade fire. It would be easy to get men into such a trench, but a thundering big job if you wanted to get them out again to make a counter-attack. They destroyed the power of offensive or aggressive action; and the lack of continuity, caused by the separate and distinct holes, made communication extremely uncertain and hazardous. Their only merit was to me their irregular trace; in all other respects they simply demonstrated how a trench should not be made."

General Comments.

Bicycles were largely used by the Boers, but hardly at all by the British; the former seem to have found them very useful for despatch riders.

"As many men as possible should be transported in war either on horseback or by automobiles. A portable military railway seems to be almost indispensable in war. A successful frontal attack is not now one of the probabilities of war; consequently flanking movements done quickly and with as much surprise as possible must be undertaken. It is under such circumstances as these that the value of automobiles and mechanical traction will be found."

The necessity for powerful field glasses and telescopes is insisted on, and it is recommended that a small proportion of the rifles should be fitted with telescopic sights.

THE CHINA INTERNATIONAL EXPEDITION, 1900–01.

The reports on the military operations in China include descriptions of the troops of the various nationalities that were represented. Some of these descriptions are very short and deal with little but the outward appearance of the troops. The following is a selection of what appear to be the most noteworthy features:—

The Russian Troops.

"Their discipline appeared to be excellent."

"A notable feature of their equipment was a travelling field kitchen, consisting of a boiler mounted in a special wagon so arranged that it could be in operation while in motion."

This travelling kitchen is now being tried in India.

The Americans got few opportunities of inspecting the Russian artillery. The guns were of small calibre and of obsolete types.

The Japanese Troops.

The Japanese had several batteries of small calibre and of the old Krupp patterns. They also had a battery of bronze guns which was always very much *en évidence*.

"The drill of the Japanese infantry is characterised by simplicity, directness, and precision. In the battle formation all movements are carried out at a run."

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"The compulsory service and strict physical requirements, with the system of reserves, allows Japan to put a large body of trained men in the field at short notice. And if Japan can keep the armament and equipment on a par with her soldiers she is a most valuable ally and a most formidable enemy."

This was written in 1900. It is curious that the Americans and the British were apparently the only nations that at this time formed a true estimate of Japan's military strength and efficiency; the old bronze guns did their duty well.

The French Troops.

The report on the French troops is little more than a bare statement of their organization and equipment, given without any comments except the following:—

"The French Zouaves and Chasseurs d'Afrique were well-developed men, disciplined from long service, soldierly in their manner and appearance. The French colonial troops marched poorly and seemed to be poorly disciplined."

The German Troops.

The marching of the German infantry was good although they were heavily weighted. The Germans brought no tents to China and therefore depended entirely upon billeting. One serious disadvantage of this system is the danger of infection to men and animals. The discipline of the men as far as was observed was excellent.

The British Troops.

Nearly the whole of the British force consisted of native troops from India. The Americans were impressed with the thoroughness of the orders for the mobilization and organization of the China Field Force. The equipment of the troops was considered to be very suitable except as regards the men's boots, which are reported on as being too stiff and heavy.

"The British were the best and most suitably dressed of any nation, and better equipped than the troops of any nation in the field."

The artillery horses (Walers) were not admired. "They require a great deal of grain to keep them in condition and they are lacking in endurance. They are noticeably weak in the hind quarters."

The discipline of the enormous number of camp followers with the expedition was, considering all the circumstances, remarkably good.

The Indian pack-saddle met with approval. "The whole arrangement is simple and inexpensive. It could undoubtedly be much improved by our practical people; but the idea is there and it is good." Those who know the amount of time and trouble that has been expended in designing the Indian pack-saddle will probably not feel so sanguine about its capability of improvement.

The British were apparently the only troops that had any method of supplying the men with ammunition while in action.

"The British troops take excellent care of themselves. Besides arranging for the comfort of their men and animals, they have accumulated supplies of fuel and forage, repaired the British Legation, macadamized streets, put up revetments, etc. There are many indications showing that they are experienced campaigners. The readiness with which they put up small flags on buildings, carts, and stores of all kinds; their skill in finding the supplies and valuables of the enemy; the

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posting of signs and guide posts—these, and many other details, show an experience in which American troops are deficient. Their officers, also, had superior knowledge of the character of foreign troops and knew how to conduct their intercourse with them, which was another advantage. The discipline of the British troops is excellent."

The marching of the Native infantry on the return from Paotingfu excited admiration. "Without any apparent effort they made from 23 to 25 miles per day by 4 or 5 o'clock in the afternoon."

Special mention is made of the Native Sapper and Miner mounted detachment with the Paotingfu column. "Too much credit cannot be given for the handling and work of the English sappers and miners, who, mounted on horses, with their tools on suitable racks also on horses, rode just behind the advance cavalry and rendered excellent service, repairing roads, filling mudholes and boggy places, and preparing ramps for the camping grounds which were almost always above or below the road level."

On the other hand, a floating bridge made by the Sappers and Miners (dismounted?) with the same column is the subject of adverse comment. "This bridge was a complete failure. The crossing of the British infantry shook it up considerably and it was necessary to repair it before other troops could follow. When the light transport started over, one boat sunk, thus absolutely destroying its usefulness. The failure of this bridge was due to the fact that it was badly located and also that valuable material at hand was not made use of."

Sanitation. It is interesting to note that the British, Japanese, and Germans all issued strict orders that only boiled water was to be drunk, yet not one of these three nationalities was able to enforce the order. This is surely conclusive evidence that the boiling of all drinking water on active service is impracticable.

General Comments. "While everyone engaged in the defence and relief of Tientsin did their full share of work and fighting, it is generally admitted that the Russians, who greatly outnumbered the other nationalities, bore the brunt of both, and are entitled to most of the credit for its safety and rescue."

In the capture of Tientsin native city and the subsequent relief of Pekin the Japanese did the greater part of the fighting, as is shown by the casualty list. It is interesting to note that on the day when Tientsin native city was attacked by the allies they lost over 14 per cent. in casualties. The casualties of the British troops engaged at Magersfontein amounted to 13 per cent. This comparison may give some idea of the severity of the fighting at Tientsin.

This long review cannot be brought to a close better than with a short summary of the account of the gallant defence of the Peitang Cathedral and Mission in Pekin. The besieged numbered about 3,000 native Christians, the majority of whom were women and children; the garrison consisted of 30 French and 10 Italian soldiers, one French and one Italian officer. The defence scheme was planned by Monsignors Favier and Jardin, priests of the Mission. At the commencement of the siege the garrison had only 10,000 rounds in hand.

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The siege lasted from the 19th June to the 16th August. The Chinese succeeded in placing and firing five mines under various portions of the defences, killing 5 Italian soldiers and 96 other persons; 1 officer, 5 soldiers, and about 94 others were killed by rifle fire, and 1 officer, 11 soldiers, and many Chinese Christians were wounded; 500 Chinese Christians died of starvation. When the Mission was relieved there were only 2½ ounces of grain per head in hand and only 1,500 rounds of ammunition. Probably no one will disagree with the American writer who claims this to be 'one of the noblest and bravest defences known in history.'

J. E. E. CRASTER.

ENGINEERING STANDARDS COMMITTEE: REPORT ON PROGRESS OF WORK.

This Committee has issued from their offices at 28, Victoria Street, S.W., a Report on the work done from its formation in January, 1901, up to July, 1905.

The Committee originated through a proposal by Sir John Wolfe Barry to the Council of the Institution of Civil Engineers to standardize various kinds of Iron and Steel Structures; its task has now been greatly extended, as will be seen below. It is supported by the Institutions of Civil Engineers, Mechanical Engineers, Electrical Engineers, and Naval Architects and the Iron and Steel Institute; and is financed by a small annual grant from Government, by grants from the above Institutions, and by subscriptions from the leading Manufacturers, Railway Companies, and others similarly interested.

The Work has been carried out under a Main Committee, with a Finance Committee, a Committee for Publication and Calculations, and Sectional Committees for the following:—1. Sections used in Ship-building (with Sub-Committees on (*a*) Tests for Iron and Steel Material used in the Construction of Ships and their Machinery, and on (*b*) Steel Castings and Forgings for Marine Work); 2. Bridges and Building Construction; 3. Railway Rolling Stock Under-frames; 4. Locomotives (with Sub-Committees on (*a*) Component Parts and Types, (*b*) Tyres, Axles, and Springs, (*c*) Locomotive Steel Plates, (*d*) Copper and its Alloys); 5. Rails (with Sub-Committees on (*a*) Railway Rails, (*b*) Tramway Rails, and (*c*) Tyre Profiles); 6. Screw Threads and Limit Gauges; 7. Pipe Flanges; 8. Cement; 9. Cast Iron Pipes (with Sub-Committees on (*a*) Water, Gas, Electrical, and Sewerage Mains, (*b*) Pipes for Hydraulic Power, and (*c*) Pipes for Heating, Ventilation, and House Drainage); 10. Electrical Plant (with Sub-Committees on (*a*) Generators, Motors, and Transformers, (*b*) Transformers, (*c*) Prime Movers, (*d*) Physical Standards, (*e*) Telegraphs and Telephones, (*f*) Cables, (*g*) Electric

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Tramways, (*h*) Electrical Plant Accessories, (*i*) Electric Automobiles); 11. Foreign Correspondence (Electrical).

The following are some of the publications which have already been issued by the Committee:—

1. List of BRITISH STANDARD SECTIONS (included in No. 6).—This Publication gives the sizes (but not the Properties, which are to be found in Publication No. 6) of the following sections:—Equal and Unequal Angles, Bulb Angles, Bulb Tees, Bulb Plates, Zed Bars, Channels, Beams, and Tee Bars. (1s. 1d.).

2. Specification and Sections of British Standard TRAMWAY RAILS AND FISHPLATES.—This Publication contains two Specifications:—(I.) Tramway Rails, (II.) Fish Plates. The sections for straight track vary from 90 lbs. to 110 lbs. per yard, each section increasing in weight by 5 lbs. per yard. Sections are also given of the curved rails corresponding to each weight of rail for straight track. Fully dimensioned diagrams of every section are included. (21s. 3d.).

4. PROPERTIES OF STANDARD BEAMS (included in No. 6). Demy 8vo., sewed. (1s. 1d.).

5. Report on STANDARD LOCOMOTIVES FOR INDIAN RAILWAYS.—This Publication contains the Recommendations of the Committee on Types of Standard Locomotives for Indian Railways. It includes Instructions to Designers, and Drawings for three classes of Metre Gauge and two classes of Broad Gauge Locomotives. (10s. 8d.).

6. PROPERTIES OF BRITISH STANDARD SECTIONS.—This Publication includes all the information contained in Nos. 1 and 4, together with Areas, Weights, Moments of Inertia, Moments of Resistance, etc., for all Standard Sections of Structural Steel. Demy 8vo., cloth. (5s. 3d.).

7. British Standard Tables of COPPER CONDUCTORS and Thicknesses of DI-ELECTRIC.—This Publication includes the Resolutions of the Committee with respect to Standards for Copper Conductors, and contains Tables of dimensions for single, concentric and stranded Conductors, Armour and Di-electric. (2s. 8d.).

9. British Standard Specification and Sections of BULL-HEADED RAILWAY RAILS.—This Publication includes the Specification and Sections of Bull-Headed Railway Rails. The Sections vary from 60 to 100 lbs. per yard, each Section increasing in weight by 5 lbs. per yard. Fully dimensioned diagrams of every Section are included, together with Tables of dimensions, and sketches showing the forms of Standard Tensile Test Pieces. (10s. 9d.).

10. British Standard Tables of PIPE FLANGES.—This Publication contains particulars of Flanges for different ranges of Steam pressure up to 325 lbs. per square inch, and water pressure up to 200 lbs. per square inch. Dimensions of the Standard Bends and Tees recommended by the Committee are also given. (2s. 8d.).

11. British Standard Specification and Sections of FLAT-BOTTOMED RAILWAY RAILS.—This Publication includes the Specification and Sections of Flat-Bottomed Railway Rails. The Sections vary from 20 to 100 lbs. per yard, each Section increasing in weight by 5 lbs. per yard. Fully dimensioned diagrams of every Section are included, together with

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Tables of dimensions, and sketches showing the forms of Standard Tensile Test Pieces. (10s. 9d.).

12. British Standard Specification for PORTLAND CEMENT.—This Specification contains the tests for Portland Cement recommended by the Committee. Dimensioned diagrams are given of the Standard briquette, jaws for holding same, needle for ascertaining setting time, and the apparatus for conducting the "*Le Chatelier*" test. (2s. 8d.).

15. British Standard Specification for STRUCTURAL STEEL FOR BRIDGES (to be published shortly).—This Specification will include the tests for Steel used in Bridge Construction, together with sketches showing the forms of Standard Tensile Test Pieces. (2s. 8d.).

16. British Standard Specification for TELEGRAPH MATERIAL.—This Publication contains Specifications for General Telegraph Material, together with Tables for hard and annealed Copper Wire. (10s. 10d.).

17. Interim Report on ELECTRICAL MACHINERY.—This Report gives Standard Pressures and Frequency; Speeds for direct current generators, D.C. Motors and A.C. Induction Motors. Definitions and Standard Test Conditions are also included; the latter are, however, still under consideration and must not, therefore, be regarded as final. (2s. 8d.).

18. Forms of STANDARD TENSILE TEST PIECES.—This contains dimensioned diagrams, and is inserted in all Specifications in which reference is made to the Standard Tensile Test Pieces. (1d.).

20. Interim Report on British Standard SCREW THREADS.—This Interim Report includes the recommendations of the Committee on Screw Threads, their Pitches, Form of Thread, etc. Tables are given containing the dimensions of the Whitworth ($\frac{1}{4}$-inch to 6 inches), the Standard Fine ($\frac{1}{4}$-inch to 6 inches) and the British Association Screw Threads. (2s. 8d.).

21. Report on British Standard PIPE THREADS for Iron or Steel Pipes and Tubes.—This Report contains the recommendations of the Committee on the Form of Thread and the Pitches for Standard Pipe Threads, together with a Schedule of Sizes. (2s. 8d.).

22. Report on the EFFECT OF TEMPERATURE ON INSULATING MATERIALS.—This Publication contains a full report of a series of experiments on the Influence of Temperature on the Electrical and Mechanical Properties of various Insulating Materials. The tests were carried out at the National Physical Laboratory, and also by Messrs. Crompton & Co., Ltd., and Messrs. Siemens Bros. & Co., Ltd. The Report is accompanied by numerous tables. (5s. 3d.).

24. British Standard Specifications for MATERIAL USED IN THE CONSTRUCTION OF RAILWAY ROLLING STOCK (to be published shortly).—This Publication contains some 24 Specifications for Tyres, Axles, Springs (Laminated, Volute and Helical), Copper Plates, Copper Rods, Copper and Brass Tubes, Steel Forgings and Castings, Steel Locomotive Boiler and Frame Plates, Carriage and Wagon Frame Plates, etc. (—s. —d.).

The above publications can be obtained from Crosby Lockwood & Son, Publishers to the Committee, 7, Stationers' Hall Court, Ludgate Hill, London, E.C., or at the Offices of the Committee, 28, Victoria Street, Westminster, London, S.W. The prices quoted are 'post free.'

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With the exception of Nos. 4 and 6, the volumes are issued in foolscap size, bound in strong paper covers.

The Committee has also made arrangements for the supply of Commercial sets of Templates in accordance with Reports 2, 9, 11, and 10.

The following R.E. officers have given their services on one or more Committees or Sub-Committees:—

Lt.-Col. R. E. B. Crompton, C.B., Electrical Engineers, R.E. (Vols.); Major P. Cardew, late R.E.; Capt. M. H. P. R. Sankey, late R.E.; Capt. T. H. Cochrane, M.V.O., R.E.; Capt. A. H. Dumaresq, R.E.

A T. MOORE.

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NOTICES OF MAGAZINES.

Bulletin of the International Railway Congress.

December, 1905.

The Use of Stamps on Railways (Austria).—Stamps are already used to some extent for the prepayment of goods and parcels, and it is here proposed to simplify the issue of tickets by employing stamps in passenger work.

The essence of the idea is that a paper ticket is employed, to which the affixing of a stamp of a suitable description gives value appropriate to the distance for which available; consequently the variety of different descriptions of tickets necessary to keep in stock is eliminated, in fact only one kind of ticket blank need be kept. On this the name of the destination station and the distance is printed, as required, by a machine into which a die is put, and the stamp is then gummed on.

The stamps themselves must be accounted for, but no stock book of tickets has to be kept, and account keeping is much simplified. Needless to say, the system is no use for through traffic.

The process of ticket issue, however, must be much more complex and slow than that to which we are accustomed. But when rates to a great number of stations are quoted, tickets are not usually kept except for those in most demand; and the process of filling up the blanks, especially when the rate book has to be consulted, is tedious if the work has to be done by pen. Under the stamp system the die is dropped into a machine, a treadle pressed, and the name of destination station and its distance appears on the blank. Stamps to the amount of the fare are then affixed and the ticket sold. Stamps are of different colours according to class, and bear on the face in large figures the distance and corresponding fare. Presumably the fare varies directly with the distance. Complications would arise if any differential tariff were used.

January, 1906.

Normal Danger *v.* Normal Clear.—This refers to the installation of automatic electrically operated signals, and is devoted to demolishing the arguments of those who are in favour of the "Normal Clear" type. The "Normal Danger" principle has long been generally adopted for hand-operated signals, and every imaginable precaution has been taken to ensure a signal going to the "On" position in the event of any failure. When therefore, at junctions for instance, automatic signals are contiguous to those hand operated, the possibility is introduced of having

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the section in advance shown clear while the hand-operated signal is against the train. The introduction of slotting would only shift the anomaly a block further on. The "Normal Danger" system certainly needs more wire, but actually the cost of operation is rather less. While in the "Normal Clear" system the signal is not "On" unless it is protecting a train, under the "Normal Danger" system the movement of the signal warns platelayers and others of the approach of a train. Arguments as to facility of ascertaining the working of signals by inspecting from the rear of the train have little weight; such inspection could only be of a very superficial character.

SUPER-ELEVATION ON CURVES.—This appears to be a German rediscovery of the familiar method of deriving the correct amount of super-elevation from measurement of the versed sine of a chord proportionate to the limiting speed.

C. E. VICKERS.

ENGINEERING NEWS.

December 7th, 1905.

WORN RAIL JOINTS.—M. Bouchal, of the Chemin de Fer de l'Ouest, says that the most economical method of dealing with worn rail ends is to cut off the ends and drill fresh bolt holes, practically making new rails slightly shorter than the old. If a rail is estimated to have a life of, say, 50 years in the main line, there is no joint device which will keep the ends from wearing down for that length of time. Experience shows that the great problem of maintaining permanent way lies in keeping the joints from working. There are now plenty of patterns of drills and saws which render the accurate cutting off and redrilling of rails *in situ* an easy matter. Of course, chaired rails would be much simpler to deal with than flatfooted rails dogged to sleepers.

December 28th, 1905.

REINFORCED CONCRETE RESERVOIR, FORT MEADE, SOUTH DAKOTA.—The account given of this piece of work is interesting, as it describes the construction in some detail. The reservoir is for the supply of a "Post" for 8 troops of Cavalry, and its capacity is 500,000 gallons; it is sunk in the ground, and divided into two compartments, each 50′ × 60′ and 16′ high from floor to under side of roof slab. The roof is required to support 24″ of earth, and a snow load of 100 lbs. per square foot.

The walls are about 12″ thick, with reinforcement of horizontal bars, inside $\frac{3}{4}$″ corrugated at 12″ centres, and outside $\frac{1}{2}$″ corrugated at 24″ centres. There is a series of supporting columns, 14″ square, 16′ 8″ apart in the one direction and 15′ in the other.

The floor appears to be about 9″ thick, reinforced on top side only by longitudinal bars in each direction, making a grillage. Footings under

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columns and walls are carried down a foot deeper, and are reinforced on the under side also.

In laying the floors and footings a thin layer of concrete was first put down; then the lower series of bars was laid, then the upper series, and both were wired together *in situ*, after which the remainder of the concrete was filled in.

In building the walls the whole skeleton of reinforcement was erected first, the bars being spaced by templates having holes bored at correct distances, and the whole wired together. (This seems to imply vertical rods, but they are not indicated on the drawing). The inside was finished in cement mortar, one cement to one sand, trowelled on.

The writer expresses a preference for placing the mortar against the casing just before the concrete is filled in, rather than the method of plastering afterwards.

C. E. VICKERS.

ENGINEERING RECORD.

November 11, 1905.

TESTS OF REINFORCED CONCRETE BEAMS.—The Chicago, Milwaukee, and St. Paul Railway recently made a series of tests of armoured concrete beams, with a view to ascertaining the most suitable design for flat-topped culverts, of which they construct a considerable number. Particular regard was paid to failure by shearing.

Tests of a considerable number of different arrangements of rod reinforcement were made, and the formula deduced was:—

$$\frac{M}{bd^2} = \cdot 350.$$

No precise results were arrived at as to the best arrangement of diagonal reinforcement; but it was reckoned to be advantageous to use steel of high elastic limit, and not to put in more sectional area of steel than about ·70 per cent. of the area of concrete above the lower layer of bars, or the bars would come too close together.

The following conclusions are noted:—

1. Diagonal reinforcement should be used at the end of all concrete beams.
2. Diagonal reinforcing bars should be brought well up to the top and securely anchored against slipping.
3. Use of small bars is preferable.
4. Use of bars larger in diameter than 1 in. is objectionable.
5. Location of neutral axis varies with amount of steel and class of concrete. With beams where ·75 per cent. of steel is used, as in these experiments, the neutral axis is about $\frac{1}{3}$ of the distance from the steel reinforcement to the top of the beam.

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In connection with armoured concrete it may be worth while drawing attention to the warning recently sounded in the Engineering press as to the danger from fire to which such structures are exposed if the armature is too close to the surface of the concrete.

C. E. VICKERS.

NATURE.

January, 1906.

TELEPHOTOGRAPHY (*p.* 227).—Dr. Merzbacher, with two companions, has been engaged during the years 1902–3 in exploring the central Tian-Shan Mountains, which lie north-east of Kashgar. He has been able to correct many errors in existing maps. Each glacier, each valley, each ridge was in turn visited, surveyed, and described. The position of the great peak of Khan-Tengri (23,622 feet) was correctly fixed, but he was unable to climb it, and points out the causes of his failure to do so. The Inglchek glacier was found to have a total length of 45 miles in place of 7 miles as previously supposed. His book contains many beautiful views of mountain scenery taken by the telephotographic process, which was used with excellent results. The view of Khan-Tengri was taken from the north at a distance of about 24 miles.

BEELZEBUB, THE LORD OF FLIES (*p.* 238).—Mr. Shipley, F.R.S., delivered an address, before the British Association at Pretoria, on insects as carriers of disease. He shows that, though King Solomon sent to Tarshish for gold and silver, ivory, and apes and peacocks, and at the present day people mostly go to Africa for gold, diamonds, ivory and game, the great obstacles, which have for generations succeeded in keeping this great continent, except at the fringes, comparatively free from immigrants, are insignificant members of the order Diptera. We can now, however, to a great extent control these troubles; the old idea, that there is something unhealthy in the climate of the tropics, is giving way to the knowledge that the unhealthiness is due to definite organisms, conveyed into man by definite biting insects, and we have at last an explanation of why Beelzebub was called the Lord of Flies.

THE FIGHTING MAN OF JAPAN.—By F. J. Norman (*p.* 271).—The Dutch appear to have been the first to attempt to train a Japanese naval force, and it is a remarkable fact that in the fifteenth century many modes of self-defence were practised by the Dutch that are almost identical with those used by the Japanese in the art of jujitsu. The question is, did the Dutch take their ideas to Japan, or were they taught by the Japanese? The chapter on "Kenjutsu" deals with the affection the Japanese have always had for the sword, and the great cleverness they exhibit in its use. A "shinai" or practice sword is used, made from four strips of bamboo bound together at the handle with a strong leather covering. It is allowable to combine a trip with a hit, as in the illustration one

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fencer is trying to knock his opponent over with a blow at the neck, at the same time taking his leg from under him with a sort of jujitsu trip. The "sumo" or wrestling between two experts is an event of almost national importance, and the Japanese flock in thousands to the huge amphitheatre, in the centre of which the tussle takes place.

BRONTOSAURUS (*p.* 282).—In 1897 the American Museum expedition to Wyoming discovered the skeleton of the Brontosaurus which is now mounted at New York. These animals spent a considerable part of their lives in the water, but were also capable of progression and of feeding upon land, where during the reproduction and hatching period they had to guard their nests. The estimated weight of the animal when alive is 38 tons, and the length of the mounted specimen over all from head to tip of tail is 66 feet 8 inches. These dimensions may be compared with those of a full-grown "sulphur bottom" whale shown at the St. Louis Exposition, which measured 74 feet 8 inches and weighed 63 tons.

THE VOYAGE OF THE "DISCOVERY" (*p.* 297).—Captain Scott, R.N., in his two interesting volumes, describes the work of the National Antarctic Expedition. The book is illustrated by a series of fine photographs and some beautiful sketches by Dr. Wilson. The two main achievements of the expedition are Captain Scott's fine sledge journeys to the farthest south, 82° 16′ 33″, and to the farthest west that was reached in Victoria land, 77° 51′. This last spirited performance would probably have been even more successful but for the death of the dogs, and Captain Scott considers the journey westward, on to the plateau of Victoria land, to have been more severe than that to the south. He says, "I cannot but believe we came near the limit of possible performance." The *Discovery*, though designed for Antarctic exploration, of magnificent strength, was found to have very poor sailing qualities and a fine capacity for rolling, sometimes going over 90°, lurching from side to side in the most uncomfortable fashion.

W. E. WARRAND.

REVUE D'HISTOIRE.

January, 1906.

STAFFS AND MILITARY CABINETS DURING THE CAMPAIGN OF 1870–1871.—Many examples are brought forward to show how the French generals habitually allowed their aides-de-camp to assume the functions of the general staff, and practically superseded the chief of the staff, with disastrous results. Bazaine was the most conspicuous example, but Macmahon, Wimpffen, Bourbaki and others acted to some extent in the same way.

CAMPAIGN OF 1794.—*Army of the North.*—Unsuccessful attempt of the French forces to raise the siege of Landrecies by an advance from the south (April 21st).

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PURSUIT OF THE ENGLISH ARMY BY MARSHAL SOULT (*2nd—16th January*, 1809).—Soult's mission was to pursue the English to their port of embarkation *l'epée dans les reins*. Commandant Balagny complains that he was overcautious in the execution of it. Especially at Lugo, where the two armies faced one another for two days, "Marshal Soult showed an excess of timidity, or at all events of prudence."

WAR OF 1870–1871.—*Army of Chalons.*—In discussing Macmahon's responsibility for resuming the advance on Metz, the writer quotes Napoleon's dictum that a general in chief command in war cannot shelter himself under the orders of a minister or of a prince who is at a distance from the field of operations and does not know the actual situation; if he disapproves those orders, he should insist on their being changed or resign his post. The result of Macmahon's vacillation was that very little progress was made towards Montmédy in three days (August 26th—28th), and two of his corps practically marked time; yet the troops were harassed and disheartened.

E. M. LLOYD.

THE CAVALRY JOURNAL.

January, 1906.

We welcome with sincere wishes for the best of success the first number of this latest Service publication. There is now required only an Infantry Journal to place us in this respect on an equality with the Army of the United States.

The new venture is published with the sanction of the Army Council and under the direction of the Inspector of Cavalry. Its office is at the Royal United Service Institution, the publisher is Mr. C. Gilbert-Wood, and the printers Spottiswoode & Co. The staff consists of Lt.-Col. A. Leetham, managing editor, Col. Hon. O. Lumley, editor, and Lt.-Col. J. W. Yardley, sporting editor; and there are sub-editors representing the Horse and Field Artillery, the Imperial Yeomanry, and Australia, Canada, India, New Zealand, and South Africa.

The Journal will for the present appear quarterly, price 2s. 6d. per copy; but it is hoped eventually to increase the number of issues and to offer substantial prizes for essays and for solutions of tactical schemes. The first year's expenses have been guaranteed, and the whole of the editorial staff are giving their services gratuitously.

This being the first number we need make no apology for a lengthy notice. The Journal appears in a cover of serviceable khaki, with a drawing of a cavalryman at the charge, symbolizing the thrusting spirit of the Cavalry arm. Its size, $9\frac{3}{4}'' \times 7\frac{1}{4}''$, at first sight appears unwieldy, but inside we find this is due to an innovation which deserves the 'sincerest form of flattery'; in order that readers may retain such articles as particularly interest them all the pages are perforated on the inner margin, and any required to be kept can be torn out and bound up in a

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volume of more normal size; a counsel of perfection would have made each article commence on a right-hand page. Another commendable feature is that each contribution is headed by a summary of its contents.

In a Foreword, Major-Gen. Baden-Powell, Inspector of Cavalry, says he makes no excuse for starting this Journal, for it has long been wanted. "As a matter of duty to our King and to the service it is the business of each one of us to try to improve the standard of knowledge in our branch, and so to make it second to none in efficiency." "Efficiency cannot be gained without knowledge. Knowledge cannot be gained without study of experiences and history."

The Preface states that the Journal is intended for the circulation of information concerning Cavalry matters in our own and other armies, and to bring the varied and scattered branches of our mounted troops, regular and auxiliary, home and colonial, into closer touch with each other by encouraging the development and interchange of ideas. The Contents are to include original articles on Cavalry subjects, translations of important foreign articles on the same, notes and reports of Cavalry progress both at home and in the Colonies, articles on sport, etc. "We British are one of the few nations which do not possess such a publication, and yet of all others we require it most, since our Cavalry comprises so many different species distributed over every part of the world." Being a race of natural horsemen we ought, with the varied methods and experiences (of the different units of the British Imperial Cavalry organizations) combined, to have the very best Cavalry that the world can produce. It is encouraging to us Sappers to see our mounted units here, as elsewhere, pointedly included in the organization of the Cavalry arm.

A coloured frontispiece gives a spirited picture of an Indian sowar galloping after a hare. It is unsigned, but bears a striking resemblance to the sketches drawn by Capt. Dixon during the siege of the "Tin Town" and published under the title of *The Leaguer of Ladysmith*. Amongst the articles of general interest are the following:—

WHAT LIES BEFORE US (THE CAVALRY FUTURE).—Major-Gen. Baden-Powell reminds us that "the mission of our Army is to second the Royal Navy in maintaining peace. If, as a nation, we do not make ourselves strong enough to defend ourselves, we are guilty of provoking others to attack us, and deserve to be smashed." "In making for efficiency in the mounted branch it must in the first place always be borne in mind that our main object is to help the Infantry to win battles." In the American Civil War experience led the men to be individually trained to every kind of action and the leaders to adopt on each occasion that which was most suitable to the local conditions of the moment; thus the action of the Cavalry on both sides was of the greatest value and at times almost overshadowed the doings of the other arms. In the recent Russo-Japanese conflict the Japanese Cavalry suffered from insufficiency in numbers, and had they possessed a proper mounted force Liao Yang would have been a disaster and Mukden a Sedan; on the other hand, the Russian Cavalry had not been properly trained as such, and were thus unable to take the

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opportunities that offered for playing havoc with their enemy's dispositions both in the field and on the lines of communication; this war is merely a confirmation of the principle of the days of Xenophon, that 'without Cavalry an army risks a great deal and cannot possibly reap the fruits of victory.'

"The careful study of your duties in war is the one and only guide to what you should train for in peace." As regards weapons, the possession of a firearm permits of Cavalry working with greater freedom and boldness. The choice of weapon must depend upon the country and the enemy:—in close and broken country, or when largely outnumbered, the rifle becomes of first importance; on open terrains, shock tactics, in combination with fire, are desirable. "But the weapon which is of the highest importance to a Cavalryman is his horse, and practical horsemastership is his most useful qualification."

MOUNTED RIFLES AND MOUNTED INFANTRY.—An anonymous contribution shows that considerable confusion exists as to the *rôle* of these. Mounted Rifles (sometimes called Light Horse, and in ancient times Dragoons), such as most of our Colonial mounted forces, are horsemen capable of carrying out all the duties of Cavalry except shock tactics, for which latter they lack the necessarily long and special training. Mounted Infantry are intended for Infantry action pure and simple, but possess means of conveyance which give them a greater mobility. The confusion of ideas has arisen through Mounted Infantry having on service, owing to the lack of horsemen trained as Cavalry, adapted themselves to the work of Mounted Rifles.

RAIDS AND HORSEMASTERSHIP.—An unknown writer proves that the long-distance rides on the Continent, which originally led to some cruelty due to inexperience, have placed our neighbours in a better position than ourselves to emulate the deeds of our own officer-scouts in the Peninsula. "Fast long-distance riding has proved itself to be practicable for horses and men, provided proper precautions are taken; these precautions can only be ascertained by practice and experience." "It is now known that a horse, if thoroughly trained, and ridden by a man who understands long-distance riding, can cover up to 60 miles at a rate of 12 to 15 miles an hour." Perhaps the best known raid was Stuart's 150 miles (including a river crossing and a fight) in 3 days to Gettysburg with 6,000 men; other long distances are 145 miles in 28 hours, 140 miles in 31 hours, and 170 in 66½. Col. Dodge of the U.S.A. is quoted as saying 'Knowledge of pace and the instinctive feel of the horse's condition is the highest grade of horsemanship.' Experience shows that the best pace for the greater part of a long ride is the canter.

Lieut. Paget-Tomlinson, 7th Hussars, in a prize essay at the Cavalry School at Netheravon, gives some useful hints on horsemastership with special reference to long-distance rides. "The horse must be in perfect condition to start with; and his condition depends entirely on the way he is cared for by his rider in the stable"; everyone knows the usual condition of the 'spare horse,' who has no one permanently detailed to look

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after him. "Steadiness and regularity of pace are all-essential factors." The rider should practice changing the horse's leading leg at the canter, and even at the trot; he should sit square and steady, and not quit stirrups; he should always slow up to a walk up or down hill; and he should periodically dismount and lead the horse, especially when the going down hill is bad (the horse's back is relieved of the weight and the blood is allowed to circulate freely under the saddle—a sure preventive of sore back). The horse should be watered slightly whenever possible, especially in hot climates; and should receive a small feed, after watering, at each halt of half-an-hour's duration (say after every two hours). The Inspector of Cavalry in his Remarks quotes the following from the second prize essay:—'The first duty of a horsemaster is to ascertain, as soon as possible, the characteristics of the horse of which he is in charge': 'off-saddle completely when halting to rest, and allow the horse when off-saddled to roll.' He also alludes to the necessity of the horse itself being well-balanced; lays down 1 lb. of forage an hour for the 24 hours as the rate of feeding; advises the carrying of meal to make gruel; and refers to the sustaining properties of sugar.

CULTIVATION OF THE SENSE OF DIRECTION (THE STARS AS A GUIDE).—Major Smyth, v.c., The Carabineers, gives three star-charts to show how any man can find his way North and South by Orion, visible, between his rising and setting, from any spot on the earth. A line drawn from the centre star of the belt through the head strikes the Pole Star; a line drawn from the centre of the belt to the centre of the sword may be continued to the imaginary South Pole of the Heavens, roughly determinable from the Southern Cross and the Triangle. Incidentally the writer mentions that in Somaliland the Indian Camel Corps sowars made better despatch riders than the Somalis trusting to their knowledge of landmarks.

DEVELOPMENT OF MOUNTED INFANTRY TRAINING AT HOME.—Col. A. J. Godley, Irish Guards, Commandant School of Instruction for M.I., shows that the three Mounted Infantry Schools at Longmoor, Bulford, and Kilworth, when in full working order, will produce 20 battalions, the men of each company being all from the same battalion of infantry; these 20 battalions are to receive a three months' training every year. Before the S. African War there were only 2 battalions of M.I., the companies then being composed of sections from various units.

CAVALRY: ITS TRUE FUNCTIONS IN MODERN WAR.—Mr. C. S. Goldman, author of *With Gen. French and the Cavalry in South Africa*, and one of the original promoters of this Journal, contributes a warning against the idea, attributed (but erroneously we think) to our authorities, that the great power of modern Cavalry lies in dismounted action. He quotes the leading writers on the Continent—von Bernhardi, von Kleist, and von Pelet-Narbonne—; and from the works of the last-named extracts a criticism of the achievements of our Cavalry in South Africa and a just conception of the proper proportion due to them of the credit for the

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capture of Cronje. The true *rôle* of Cavalry is summed up in the dictum that they should "fight mounted when they can, dismounted only when they must."

THE CAVALRY OF THE BRITISH EMPIRE.—Major-Gen. Sir E. Hutton draws attention to the great reserves we possess in 'The Cavalry of Greater Britain,' who "make up in the sterner qualities of men what they lack as soldiers in the European sense of the word." Another contributor gives a list of 'The Mounted Forces of the British Empire,' including 2 Camel Corps Companies of the King's African Rifles, the Mounted Infantry of St. Kitts Nevis, and the Trinidad Light Horse.

TETHERING SINGLE HORSES TEMPORARILY.—A tip now used in the Cavalry. Taking, for example, the near side:—Pass the loop of the reins from front to rear between the girths and the horse's side. Draw the near rein tight until the horse's head comes round towards his shoulder. Pass the near stirrup iron and leather through the loop behind the girth. Draw the loop tight by pulling the off-rein forward and letting it hang loose over the horse's neck. Thus tethered the horse can only move in a small circle.

HEIGHT OF POLO PONIES.—'Cavalier' pleads for raising the height to 15·2 hands. Owing to want of stabling accommodation cavalry officers have to buy and sell their hunters and polo ponies each season. It would be a great economy if they could use the same animal for hunting, polo, and parade.

The whole number breathes the spirit of our modern Cavalry, practicability and common sense, derived no doubt from the happy chance of the South African War bringing them into close association with their brethren from the Colonies.

A. T. MOORE.

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CORRESPONDENCE.

THE PREVENTION OF DAMPNESS DUE TO CONDENSATION IN MAGAZINES.

DEAR SIR,

Major Naish, in attributing to me in the last issue of the *R.E. Journal* a belief in a revolving cowl as a sort of universal panacea for dampness in magazines, misses half the point of the application of the well-known principle to which I referred in my letter in the December number.

The principle is based upon the absorbent and drying properties of moving air and its tendency to equalise the temperature of the objects over which it passes. The application is to be found in a system of thorough ventilation.

The two first essentials of thorough ventilation are efficient inlets and out-takes. Revolving cowls will furnish the latter, but the former are of equal importance.

In many magazines, not of the latest type, including several of those of the Halifax batteries as they existed 6 years ago, practically the only inlet is round the edges of a tightly fitting door. Of the two essentials one is insufficiently found.

Major Naish refers to underground Stores, which in summer ran with moisture until holes were broken through their rear walls, when they became at once "bone-dry." It is suggested for consideration whether it was not the improvement in ventilation afforded by these holes that produced this desirable result.

The dryness of the Stores in winter may be accounted for by the fact that their temperature was then higher than that of the external air. Consequently the air that found its way in from the outside, instead of condensing and depositing moisture, expanded, whereby were increased both its capacity for absorption and to a small extent the general circulation and the up-draught through the extracts.

Yours truly,
H. J. WALKER,
Capt., R.E.

The Editor, "R.E. Journal."

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RECENT PUBLICATIONS.

Regulations for the Equipment of the Army. Part I. (1s. Wyman & Sons).

The Russo-Japanese War. Japanese Official Reports, compiled by M. Kinai. Vol. I. (7½ × 5. The Shimbashido, Tokyo).

The German Official Account of the War in South Africa. Vol. II. Authorized translation by Colonel H. Du Cane, M.V.O., R.A. (9 × 6. 15s. Murray).

Der Kleine Krieg in Afrika, von F. Ohle. (4½ mks. Berlin).

Festungskrieg. Eine applikatorische Studie über den modernen Festungskampf. Heft 2. Der Kampf um ein vorgeschobenes Einzelfort. von Major Schwarte. (5 mks. Mittler & Sohn, Berlin).

Wolfe and Montcalm, by the Abbé H. R. Casgrain. (10 × 6. 21s. Jack).

L'Armée Idéale, par Colonel A. Boucher. (5 fr. 8vo. Lavauzelle, Paris).

Die Fortschritte auf der Gebiete der drahtlosen Telegraphie, von A. Prasch. (8½ mks. Berlin).

Tables of Imperial, Metric, Indian, and Colonial Weights and Measures, compiled by A. J. Martin, F.S.I. (2s. 6d. Fisher Unwin).

Valves and Valve-Gear Mechanisms, by W. E. Dalby. (10 × 6. 21s. Arnold).

Theorie und Konstruktion versteifter Hängebrücken, von F. Bohny. (5 mks. Berlin).

Projektierung elektrischer Licht-und Kraftübertraggsanlagen, von P. Stierstorfer. (8 mks. Berlin).

Our Stellar Universe: Steroscopic Star Charts and Spectroscopic Key Maps, by T. E. Heath. (10s. King, Sell & Odling).

Le Bois, par M. J. Beauverie. 2 vols. (20 frs. Gauthier-Villars, Paris).

The Science Year-Book for 1906. First year. Edited by Major B. F. S. Baden-Powell. (5s. King, Sell & Odling).

Urdu Reader for Beginners, by Major F. R. H. Chapman, Instructor in Hindustani at the R.M.C., Sandhurst. (10 × 6½. 7s. 6d. Thacker).

Japanese Conversation in Six Months. A new method. By W. A. Adams. (9 × 6. 4s. Kegan Paul).

A Fantasy of Far Japan, by Baron Surgematsu. (10s. 6d. Constable).

Lectures on Tropical Diseases, by Sir Patrick Manson. (7s. 6d. Constable).

Seamanship for Small Yachts, by F. B. Cooke. (8½ × 5½. 2s. 6d. *Yachtsman* Publishing Company).

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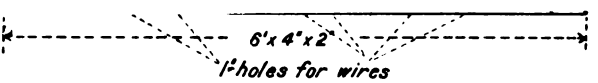

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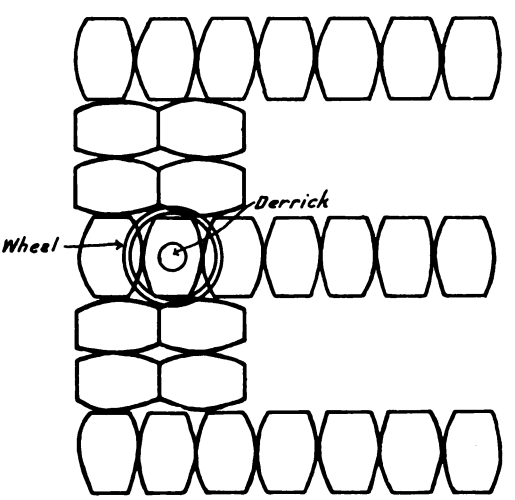
FIG. 4 SWINGING DERRICK ON BARREL RAFT



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SANDHURST, JUNE & NOVEMBER.—Twelve out of **thirteen,** the 13th being only 87 marks out.

WOOLWICH, JUNE & DECEMBER.—Five passed.

MILITIA LITERARY.—Three passed.

QUALIFYING, SEPTEMBER.—Two passed.

INDIAN POLICE, JUNE.—One out of **two** who went up.

MILITIA COMPETITIVE, MARCH & SEPTEMBER.—Nine out of **ten** passed. For the **QUALIFYING UNIVERSITY & COLONIAL.—Two** passed.

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August, 1904.

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August, 1903.

TWELVE passed in the Competitive List and FIVE received Nominations.

August, 1902.

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Militia Military Competitive, March and September, 1905.

FOURTEEN PASSED.

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THE ROYAL ENGINEERS JOURNAL.

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18th	C. H. Lemmon.	50th	H. G. Worsley.
*19th	W. E. Buckingham.	*56th	B. F. Rhodes.

SANDHURST.

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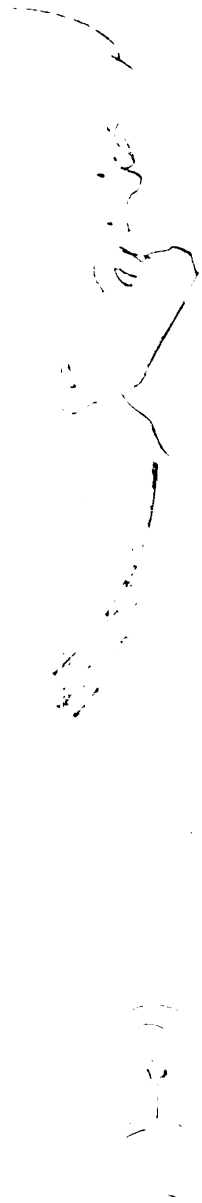

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BARR AND STROUD RANGEFINDER, F.Q. TYPE, "INFANTRY," 1 METRE BASE, FOR USE WITH INFANTRY, CAVALRY, AND MACHINE GUNS.

This Rangefinder is constructed largely of Aluminium and is covered externally with brown leather. It is fitted with pads on the ends to prevent damage by rough handling. It is supplied in a strong leather case, as shown, fitted with a shoulder-strap.

The tripod shown in the illustration is not supplied with the instrument, as the Rangefinder is so constructed that it can be used with ease without a stand.

Approximate uncertainty of observation:—

1 yard at 400 yards.
5 yards at 1,000 yards.
40 yards at 3,000 yards.

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*STRATEGY IN RELATION TO COAST DEFENCE.**

By Capt. E. J. W. Slade, M.V.O., R.N.

Before discussing the question of the defence of our coasts, we must first of all form some idea of how they can be attacked, and what parts of them are liable to attack. Then we must place the question of defence in its proper relation to the general strategy of the war, for we must be careful not to think of it as a thing apart from the whole scheme of operations. Whatever nation we may be engaged with, the main lines of strategical operations must be worked out as a whole, taking in the operations of all the fighting forces of the crown, and not looking on the two main divisions of them, the Army and Navy, as separate units, which have little or nothing to do with one another and which can act along different lines each more or less independent of the other.

Being an Island Power we hold a different position as regards our frontiers to that held by all other Great Powers with the exception of Japan. An enemy is obliged to cross the sea in order to attack any portion of our frontier, and he is therefore obliged to embark on the element on which we pride ourselves as being the paramount Power. In order to do this he must send an expedition from his coast to ours, and the importance of this expedition varies with the object that he has in view. It may be one of three kinds :—a Raid, a Diversion, or an Invasion.

A *Raid* is an expedition fitted out to damage some portion of our national property and so hamper any movements that we may be contemplating. Good examples of such expeditions are Drake's expedition to destroy the ships fitting out for the Armada, the Dutch raid on the Medway to destroy the shipping and Naval stores, and our expedition to Washington in the American War of 1812.

A raid may be an expedition of any size from a single ship to a force of considerable magnitude, say 10 or 12 thousand men ; but the essential feature is that the objective is merely destruction and not occupation. The object attained, the expedition withdraws, and the operation may or may not be repeated in another quarter.

* *Abstract of Lecture delivered at the Royal Engineers Institute on 22nd February*, 1906.

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A *Diversion* is a more serious operation, and is as a rule conducted by a large force. Its object is to divert or draw off a considerable portion of the enemy's forces from the main theatre of operations. Let me take as examples Napoleon's expedition to Egypt, his expedition to the coast of Ireland, his projected expedition to Scotland, and perhaps also, when considered in relation to the main lines of the Napoleonic wars, our Peninsular Campaign.

Lastly we have *Invasion*, which means a very large force, sufficient not only to subdue the main forces of the enemy but to occupy, hold, and administer the territory conquered. We need not go further back in history for an example of this kind of expedition than the war which has just closed.

There are many expeditions in history which are on the border between two kinds, or which pass from one to another according to the opportunities which arise; but there is one characteristic which is fairly constant and that is the degree of importance of the oversea communications. In the first class the expedition is self-contained and the communications are practically *nil*; the expedition is launched out into space, and stands or falls by its own strength. In the second the communications are more serious, and the expedition will probably be accompanied by a much larger fleet of store ships and transports than in the first case; and at the present day it will most probably be dependent on a line of supplies from its own base, at any rate for a portion of the time during which it is acting. In the last case the communications must be continuous, and any interruption of them will entail serious consequences and will most probably lead to the ultimate defeat of the expeditionary forces.

In the days when wind supplied the motive power of our ships the communications of our fleets were not such a matter of vital importance as they are now, as the ships could exist for comparatively long periods without being obliged to have recourse to their base of supply. But now that steam is the only means of propulsion they cannot live without a constant supply of coal, oil, and water, and this fact makes them extremely sensitive to any threat on the line by which these necessaries are supplied. Even in the days of sails communications played a great part in Naval warfare; our abandonment of the Mediterranean in 1799 was brought about solely by the success of Napoleon in dragging Spain into the war against us, and so forcing Jervis to come back to a position off Cape Finisterre where he could cover the line of his communications.

It is said that in land warfare strategy is mainly a question of communications, and the same holds good at sea in the present day. It is therefore evident that the first principle of coast defence is to ensure that the enemy's communications are unsafe.

From this it follows that for a first line of defence in all circum-

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stances we must maintain command of the seas that surround our coasts.

The term command of the sea is often used very loosely, and it may be as well to explain what it means.

The command of the sea may be absolute as in the case of our South African war, but that is a state of affairs that will not happen if we are engaged in war with any European Power. It then becomes partial, or perhaps a better word would be potential. It then means that the enemy cannot bring any force to bear on any portion of the area of operations without our being able to concentrate a stronger force on him before he can do much damage. It does not mean that the enemy cannot send any ships to sea, but it does mean that, if they get to sea, they will be dealt with before they can effect much and we hope that they will not get home again.

Now let us apply this reasoning to the question of attack on our own coasts, and see how it affects the situation. We will take the case of invasion first. Since this will require a constant stream of transports to maintain the troops when once they have landed and to supply the fleet that is covering the disembarkation, it follows that it is an impossible operation until the control of the line of communications has passed out of our hands. The operation of disembarking the troops and stores cannot be completed in a few hours and the transports will be liable to attack during the whole time that it is in progress. If we grant the hypothesis that the command of the sea enables us to concentrate a superior force on any hostile body of ships that are attempting to operate against us, then it follows that the hostile fleet itself will be unable to effectively cover the landing and the expedition must end in disaster. Another point is that no such operation could hope to succeed by surprise, as the collection of the necessary troops and transports could not be concealed, and from the suspension of sailings of liners we should have ample warning of its preparation. We probably should not know the exact spot at which it was intended to land, but we ought to be able to deal with the expedition before it reached our shores.

The same applies to the case of a diversion, but in a minor degree. A diversion would necessitate a smaller force, fewer transports, and a less important line of communications. It would probably be directed against an outlying portion of our islands, such as Ireland, where the enemy would hope to get assistance from the disaffected portion of the inhabitants; but the invaders would probably fall a prey to our fleet before they could complete their disembarkation.

A raid is on a different footing. It will be pushed home by evasion of our ships, and it will depend upon the rapidity of its movements and the unexpectedness of the attack to surprise the spot aimed at before adequate arrangements are made for its defence.

The severity of the blow in the case of success will to a great

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extent determine the probable objective of such an attack ; and any of our large shipping centres and manufacturing or shipbuilding towns on the coast may expect such a visitation at, or even before, the actual declaration of war. Such places as the Tyne, Barrow-in-Furness, Liverpool, the Clyde, are all liable to attack, those that are most exposed being more liable than those that are more or less protected by their geographical position. Our Naval bases may also be raided if the enemy imagines that we are unprepared to meet him.

A raid may or may not be accompanied by troops, according to the circumstances, but it is improbable that any warships except cruisers will be so employed. It is very easy in the present day to fire away the whole of a ship's ammunition in a very short time, and foreign ships carry much less ammunition per gun than ours do. Imagine the feelings of a foreign Admiral, who had expended a considerable portion of his ammunition in a bombardment of the defences of any of our ports, and then suddenly found himself confronted with a British squadron with full magazines and forced to fight an action of perhaps hours' duration.

A raid might be attempted by troops alone without any naval escort. They would hope to attain their object by surprise ; and would surrender the moment that the destruction aimed at was carried out or the forces brought against them were sufficient to make resistance hopeless. This would perhaps be the most likely form for a raid to take at the beginning of the war, particularly if the enemy was one that could well afford to lose a few thousand men provided they could strike an effective blow at our Sea Power.

The points most vulnerable next after the manufacturing centres, or perhaps equally with them, will be the long-distance wireless telegraph stations. These are Poldhu in Cornwall and the stations being erected in Scotland and Ireland. Of these Poldhu is liable to destruction from bombardment by a single ship, and we may expect the attempt to be made as soon as possible after the commencement of hostilities, if not before. The attempt may or may not be followed by a disembarkation to seize and destroy the instruments, but this ought to be easily dealt with. The other stations are to be placed inland, out of range of guns, and it will be necessary to land in order to injure them.

The means to be taken for our defence can now be more closely considered. Since we are not likely to be called on to face an invasion, large fortified positions in the interior of the country are not necessary ; nor is any elaborate preparation advisable for the concentration of a very large army in the neighbourhood of London.

Similarly defence against a diversion should not take the form of permanent fortifications ; we must trust to the Navy to see that the

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operation fails through the destruction of the covering fleet and of the line of communications.

A reasonable amount of defence must be given to those points which offer a bait for a raid, and this defence must be proportioned to the force which is likely to attack. A Naval Base Port, such as Portsmouth, Plymouth, and Chatham, must be provided with such an armament that it would not be worth the risk for any hostile ship to come within the area from which the docks and basins could be bombarded. The distance at which a bombardment can now be carried out is much greater than was formerly conceived to be possible, and we may consider that ships might now attempt to throw shell into a dockyard from a range of anything under 15,000 yards; whether they consider that the damage that they will do is worth the ammunition that they will expend I cannot say, but the possibility is there and it must be faced. The effective range of well-placed heavy guns against ships may also be taken as about 15,000 yards; and therefore it is evident that the placing of batteries in front of the line to be defended, as long as they have a clear range for their guns, may be considered as forming an adequate defence. It is not necessary to have very many of these guns, but there should be sufficient to make the risk to the enemy very considerable. It is then probable that the attempt will never be made, and the mere fact of the presence of these batteries will keep the enemy from trying to find out how strong they are.

The larger and more important Commercial Ports, containing as they do vessels of all sizes, most of them capable of use to the State during war, either as transports for troops, auxiliary cruisers, or storeships or colliers for the Fleet, are all liable to attack. Besides the ships there are also the shipbuilding yards at which war vessels of some sort or another are always under construction, and the destruction of these would mean a severe blow to our Sea Power. It is not at all likely that the enemy's battle-ships will attempt anything of this sort, as it would only expose them to being brought to action by our battle fleet with their own magazines already depleted and their ships perhaps already slightly damaged. Cruisers, either armoured or protected, are the most likely vessels to be used as the covering force for the expedition, and it is therefore necessary to provide an armament that will delay them from carrying out their plans before reinforcements can be brought up by us.

An expedition totally unescorted may also attempt to rush a place, but its ability to do so will depend upon the amount of warning it gives.

The enemy will attempt to land on some part of the coast clear of the fixed defences, and will endeavour to capture the docks and shipbuilding yards by a *coup de main*. This will limit the distance from the point of attack of the site selected for the disembarkation, and it

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is therefore only necessary to closely watch a short extent of coast line. Such a disembarkation should never be allowed to take place unopposed, and a very small number of men properly placed, even if only behind hedges and walls, would be quite sufficient to make it a work of very great difficulty and danger. It must be remembered, however, that it will be too late to get the men to their stations, if we wait until the ships are sighted, for under modern conditions it would be quite possible for a covering force to land within an hour of the first appearance of the ships on the horizon. It is obvious that the proper time to deal with all such expeditions is during the period that the men are crowded together in the boats, without cover of any kind and incapable of making any defence, and having probably from ½ to ¾ of a mile of water to cover before they can set foot on the beach and then a further 100 yards or so of very bad ground to get across before they can reach any shelter. The advantage here is all on the side of the defence, for with modern weapons and smokeless powder it would be almost impossible for the attacking party to locate the position of the defenders.

I have not touched on the use of the torpedo boat by night or the submarine by day as a defence against such attacks. Provided they can get to the spot in time, they ought to be able to make certain that the transports and some of the escort, if there is any, should not get away again. They may not be able to prevent a disembarkation, as a submarine, even if she did arrive before the men were landed, would not be able to do more than sink the transport, and if the latter was moored in shallow water no great harm would be done.

The relation of coast defence to the general strategy of the war will of course depend upon the nation with whom we are fighting. If the coasts of the enemy are close to ours and the time required for the transport of an expedition is small, then the amount of cross raiding may be expected to be considerable. If we are fighting by ourselves, without Allies, then the question of coast defence will assume a greater degree of importance than if we had Allies, as the whole efforts of our enemy will be devoted to attempting to strike such blows as may induce us to come to terms. Attempts at diversions may be expected in Ireland, and efforts will be made to injure us in every possible way, and the only defence is to maintain such preponderance at sea that the enemy's efforts will be in vain.

Another form of defence, and in many ways the most efficacious form, is that of counter-attack. For example let me remind you of Pitt's famous "System" in the seven years' war. France was then preparing to invade us, and the plans that were then drawn up were those that were eventually adopted by Napoleon half a century later. Pitt refused to take any active measures for defence of the coasts, even to the extent of refusing to call out the Militia at first. What

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he did do was to collect an army of about 10,000 men in the Isle of Wight and threaten the French coast; this was sufficient to stop all attempts at oversea operations, and the effect, as described by a French historian, was that every general, the whole length of the coast, saw himself threatened and called loudly for reinforcements.

I have not touched on Colonial coast defence, but this in its main features is governed by the same principles as the defence of the coasts of these Islands. There is, however, one great difference in the character of the lines of communication. On land we look on the lines of communication as running in opposite directions from the respective bases to the front, the outer end of each terminating at the fighting line. At sea this is different. In the majority of cases the lines of communication are parallel, and generally identical; so that any attack on the communications of the enemy, instead of exposing our own line, as often happens on land, ensures its safety. This peculiarity is a most important one, and it is one that is not always recognised. It will enable us to nip in the bud any attempt on our Colonies, and it will at the same time keep our own communications free from all danger of serious interference. But this does not provide for the possibilities of raids by isolated cruisers with the object of doing damage, and therefore we are obliged to provide certain fixed defences in order to protect the vital points.

There is one point I should like to bring before you, and that is the importance of providing a certain measure of fixed defences, not necessarily as a protection against the enemy, but as protection against ourselves. We have a population that is ignorant of all the principles of the art of war, and which is democratic and accustomed to make itself heard and felt. If 'the man in the street' imagines he is in danger, he will bring pressure to bear on the Government to provide what *he* considers necessary for his safety; and no government will be strong enough to resist the demand, although it may know perfectly well that the fears are without foundation. We have only to look at the Spanish-American War to see what the effect may be. The strategical arrangements on both sides were largely upset because the idea got about that each was going to attack the home coasts of the other. The American towns on the Atlantic coast took alarm when Cervera sailed from Cadiz, and forced the Government to form what was called the Flying Squadron. This in its turn reacted on the Spaniards, principally on account of the name, and prevented them from sending out a sufficient force to enable Cervera to do his work. Here is an instance of what Clausewitz calls the 'Friction of War'; and although such nervousness has no real foundation, it is nevertheless a fact which must be taken into consideration. However much we may deplore the constant interference of ill-informed and ignorant people with the plans of professional strategists, we cannot ignore them; and it is as much part of

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the Art of Strategy to foresee the objections likely to be raised and to forestall them, as it is to divine the enemy's movements under all possible circumstances.

Let me now sum up the principles that I have endeavoured to put before you.

The general strategy of a war is determined in its main lines by the object of the war. On this will depend whether our main efforts are directed against the coasts of the enemy or whether we attempt to bring pressure to bear on him by attacking his foreign possessions first. In the first case we shall have the whole of our forces concentrated on the portion of the sea immediately facing his coasts and military harbours, and the opportunities that he will have for sending out any expedition will be very small. Coast defence will then occupy but a small place in our plans, as even raids will be difficult to carry out. If, on the other hand, a large portion of our forces are occupied elsewhere, the enemy's opportunities will be correspondingly greater, and we may expect that he will attempt to take advantage of them to force us to desist from the operations that we have undertaken.

There is always this point to be borne in mind,—cruisers and battle-ships cannot be in two places at once, and cannot be doing more than one thing at the same time. If they are occupied in watching our ships and in protecting their own coasts, they cannot be used to convoy expeditions to attack ours. If the enemy wishes to use his fleet against our fleet, he will require all his cruisers for scouting and reconnaissance work and his battle-ships will all be required to strengthen his line of battle sufficiently to stand against the fleet that he will expect to meet; he will therefore have none to spare for other purposes. If, on the other hand, he decides to keep his battle-ships behind his forts, then he may be expected to use his cruisers to raid either our commerce or our coasts. Of the two alternatives it is probable that he will choose the least dangerous and will devote his attention to the commerce, but we must be prepared to find him attempting anything that offers a reasonable chance of success.

It is therefore evident that the relative importance of coast defence will vary with the general strategy of the war. We must be careful always to bear this in mind, or else we shall find ourselves underestimating or over-estimating its value and either risking too much or losing opportunities through excess of caution.

Firstly, the command of the sea must never pass from our hands. This means the control of the lines of communication.

Secondly, if we have the control of the lines of communication, then no expedition of any size can be safely despatched against us.

Thirdly, raids cannot be prevented, as they may evade the watching cruisers and they have no communications to be cut. To deal with

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raids sufficient fixed defences are required to delay them until reinforcements can come up to deal with them. The value of the bait offered will determine the localities to be defended, and the probable nature of the attack the amount of defence to be provided.

Fourthly, the value of the counter-attack, and the general relation of the whole scheme of defence to the strategical requirements of the war.

Fifthly, the importance of keeping the nerves of 'the man in the street' in good order.

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THE RÔLE OF ENGINEERS ON THE FIELD OF BATTLE.

By Col. S. A. E. Hickson, d.s.o., R.E.

Undoubtedly amongst the more important lessons taught by each succeeding big war of modern times is the increased importance of the military Engineer in all the operations of war, and, above all, of the Engineers as a combatant unit in the attack, as well as in the defence, of a position in their *rôle* as the fourth arm of the Service.

It is not the Artillery alone that must now prepare the way for the Infantry assault.* It is the sapper who, as often as not, must not merely accompany the firing line, but precede it. It is he who, with wire-cutter, saw, and axe, must clear the way for the men with the rifle, and discover and remove those mines, entanglements, and other obstacles which the defender will invariably spread to detain his enemy under the fire of his works. In some cases the Engineers of the defence will have made positions so strong that a frontal assault is impossible, as occurred to ourselves at Magersfontein and Colenso and to the Japanese at Shou-shan-pou in their advance on Liao-yang. Then a flank or enveloping attack becomes a necessity. On other occasions, if it appears that a frontal attack, perhaps by night, can succeed at all, it is to the Engineers it falls to lead the attempt, as occurred to ourselves successfully by sap and spade at Paardeburg, and as was attempted by the Japanese, when, with wire-cutters and tools,

* The following interesting extract of observations by Lieut.-Colonel Masahito Kasoi Mura, of the Japanese General Staff, Tokio, appears in the *Journal of the Royal United Service Institution* for February, 1906:—

"In our methods of attack we believe we have advanced a little beyond European methods by the application of field fortification to the attack. This does not serve us for defence, but assures us a point of rest during the forward movement. On the skirmish, or firing line, one fires while the other digs—a rifleman is immediately followed by a sapper. We work in a manner distinct from that of other armies. Our agile soldiers dig while lying down. They offer no target to the enemy, and excavate without being seen in the most advanced positions; the succeeding files find a shelter already made. Since these fortifications exist at each stage of the attack, we can dispense with strong reserves. In Germany for an attack only the reserves fortify; work with spade is only done at night when men can work standing, and only as an auxiliary means of defence. As we dig while lying down, we can entrench ourselves during the daytime, and an enemy attacking our front, although he may be superior to us, can do nothing to us without artillery."

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their Engineers endeavoured to clear a road through the Russian mines and wire entanglements, etc., in the attack on Nan-shan and also in the attack before Liao-yang, notably at Middle hill and Rocky ridge.

It is not then only when an army is shifting its base along the shore that detachments of Engineers must be sent ahead with the covering force to prepare landing stages and rafts. It is no longer only on the march that detachments of Engineers must accompany the advanced guard to prepare the roads and bridges, perhaps under fire, before the other arms can advance. It is not only in the defence of a position that the Engineer must be first on the spot, to devise, plan, and lay out cover and shelter trenches, cunningly conceal them from the enemy's view, and by artifice and ruse seek in every way to co-operate with the other arms, both by deceiving the enemy as to the defenders' real position, and by means of obstacles delaying or altogether preventing his advance. Nor is it only in the siege that the sapper must lead the forlorn hope, and fix the charge, which is to blow not only the enemy but himself to glory, provided he be not, unfortunately, shot down before he can accomplish his self-sacrificing duty. But above and besides all these functions—since every considerable action under modern conditions tends to assume the form of a miniature siege—in every attack even more than in the defence, it is now by the combined action of the Engineer co-operating with the Infantry soldier, under the sheltering fire of the Artillery, the one removing obstacles, the other covering his work by fire, that victory in the assault must in the future be sought.

In almost every serious frontal attack on a defended position it now becomes necessary to tell off with the covering force, to every extended company of Infantry in the firing line, a section or squad of Engineers, not merely to act as ground scouts, but to work with unflinching determination under the enemy's fire without even the moral satisfaction of returning it. Their essential function is as rapidly as possible to discover and remove every species of obstacle put in the way of the advancing Infantry, and to improve for the use of the attacking force any natural or artificial cover they find. Man after man may often have to nobly sacrifice himself, and for many an hour will the attacking line have to wait under a galling fire whilst these operations are on foot; but the greater the skill of the Engineer in performing them, and the greater his daring, the greater chance will there be for the final assault of the Infantry on the enemy's trenches.

The immense size of modern armies, and the immense range of modern arms,—as has now so often been proved—makes the fronts that the defender can protect, and the distances over which the assailants must march, so great that time is given to enable the defence to make the most formidable works and obstacles. The front of the

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Japanese army from Hai-cheng on their left to Mo-tien-ling on their right extended over nearly fifty miles. When at last the position taken up by the Russians before Liao-yang was reached, it was found to bristle with defence works, strongly made and artfully concealed, with mines, entanglements, and other obstacles spread along every possible line of approach. It fell to the Engineers of the attack to clear the way for the assaults—so often unsuccessful—on the strong positions thus prepared by the defenders. These attacks were sometimes made by day, but more often commenced by night and continued during the day. They were moreover often made under urgent orders that the positions must be taken at all costs, and the sacrifice of life was very heavy.

Such, briefly outlined, are the conditions of the attack on artificially-defended positions, as developed during the latest war from the Engineer's point of view. The absence, therefore, of any distinct *rôle* for the Engineers in our latest treatise on "Combined Training" is to be regretted. It is stated indeed in Sec. 122, Chap. VI., that, "if possible, parties of Engineers should always be within reach of troops attacking"; but this is the only allusion to their duties, and, if this is considered their *rôle* in the attack, it is not clear why it is not stated to be so in paras. 2 and 3 of Sec. 103, Chap. VI., where the functions of the other arms are briefly sketched. In para. 3, although the necessity for entrenching is elsewhere proclaimed, it is not laid down that all officers should gain some knowledge of engineering and make themselves acquainted with the principles which govern the employment of field defences. Nor is it even laid down that planning such defences and making obstacles is the special province of the Engineer. In fact from much of the chapter on attack the novice might be led to conclude that the enemy's fire is the only obstacle to attack, and that but for this Cavalry and Mounted Infantry could trot about unimpeded all over the field up to the very trenches of the enemy. Again in Sec. 105, Chap. VI., the intelligent use of ground is said to be the first condition for the attainment of superiority of fire; but how far this is the speciality of the Engineer, at a time when the other arms have their minds full, is not indicated. Throughout the chapter dealing with the attack and defence—although the importance of seizing and strengthening localities and of preliminary operations, such as the passage of a river and the preparation by the Artillery for the advance of the Infantry, are mentioned,—no distinctive *rôle* is laid down for the Engineers such as modern war might, from what has been written, be expected to require. Yet if, as already said, it is the Artillery who should prepare and cover the Infantry advance, it is the Engineers who must make the final assault possible; and it is they who, co-operating with the Infantry, must, under the protection of the Artillery fire, clear away the enemy's obstacles and mines.

The omission in our latest treatise on Combined Training to assign

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any specific *rôle* to the Engineers, more especially in the attack, seems all the more remarkable when it is considered how much has been said and written of the lessons of the late war in the Far East. It is possible that, in compiling this treatise, a fear existed that, if the duty of entrenching, leading, and clearing away obstacles were dealt with as the special *rôle* of the Engineers, the Infantry would incline to abstain from spade work and hang back; or that there was some revival of the old idea that all branches of the service should be able to do the work of the sapper as efficiently as himself. There seems however to be no good reason at all to fear that the Infantry soldier, if provided with tools, will not dig himself in as hard as he can for his own safety and protection—even though such duties as entrenching, mines, and the removal of obstacles are especially the *rôle* of the Engineer—just as readily as the Engineer will on occasion use his rifle, though the spade or wire-cutter be his first duty. It seems desirable therefore that this specific *rôle* of the Engineer should be discussed, and the duty of each arm in mutually supporting the other be more closely defined from the point of view of the Engineers, as well as of the Artillery, Infantry, and Cavalry. It is by the co-operation of all units that victory is to be sought.

In this respect—that is from an Engineer point of view—three deductions stand out clearly as the guiding issues of recent experience in war :—

(1). That detachments of Engineers should accompany or precede every covering party of Infantry in the firing line.

(2). That a large proportion of Infantry, not less than half, should carry tools into action and use them.

(3). That entrenching by night must be frequently resorted to, and should be assiduously studied and practised in time of peace.

The relative duties in entrenching, as between Engineer and Infantry soldier, may hence be very easily deduced. The Engineer is to be the skilled scout and guide through obstacles, the student and indicator of sites and designs, forms and sections of work, the defence of villages, etc.,—the professional adviser; the Infantry and others to lend a hand, as far as lies in their power, in the construction of works, when not required for their own more particular *rôle* as riflemen.

As the horse distinguishes the Cavalry, and the gun the Artillery, so the spade distinguishes the Engineer from the Infantry. And as Cavalry, Artillery, Engineers, and Infantry, all on occasion use the rifle, so should each, to some extent, be able to use a spade, manage a horse, or handle a gun. It is, at least, by each thoroughly understanding the *rôle* of the other that perfection in the co-operation of all is to be sought.

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Some explanation of the reason for overlooking the special *rôle* of the Engineer as an arm of the Service on the field of battle may perhaps be found in the fact that the occupation of our own Engineers in time of peace has hitherto been so closely associated with the building of barracks that the rest of the Army has failed to recognise that they have any specific *rôle* on the battle-field. It is high time, if we would be up-to-date, that this old idea passed away. The construction of works in time of peace no doubt still is, and always has been, considered the best training the military Engineer can get for many of the operations of war in which he has to co-operate, over and above his duties on the battle-field. Such, for example, are bridges, roads, railways, and telegraphs, all of which may be described as his strategical functions, in distinction from his tactical or more exclusively military functions. It is, however, the ever-growing importance of these tactical functions of the Engineer which has so enormously increased, and must and should ever force itself on our close attention. Some way has already been made by reducing the time spent on what may be called the trade of the house-builder, painter and decorator rather than of the Engineer. It is this form of engineering which is of least use to the military engineer in time of war; but nothing will be gained by giving this up, if the tactical *rôle* of the Engineer in co-operation with the other arms is not practised.

That the importance of this tactical *rôle* has enormously increased is nowhere denied; and it is hardly too much to say that, at the present time, a company or troop of Engineers should be associated with every Infantry or Cavalry Brigade, and should be constantly trained with it.

Our official treatise on Combined Training, in addition to omitting to assign to the Engineers any special *rôle* on the battle-field, appears to lay insufficient stress on 'co-operation' generally. In the first line of Chapter VI. on attack and defence, the significance of the co-operation of all arms, though each "possesses a power peculiar to itself," is indeed indicated; but it seems strange, in the face of such an announcement, that the peculiar power of the Engineers (*i.e.*, science and the spade) is not referred to, whereas the *rôle* of the Cavalry, whose peculiar power in modern tactics lies in his horse and speed, is fully considered. Although the expression 'operations' occurs frequently throughout the treatise, the term 'co-operation' gives way almost invariably to 'combination.' It may be that this term 'combination' has occasionally a special and useful application, as implying tactical skill on the part of the supposed leader or commander to make use of the several arms at his disposal. Speaking generally, however, reflection shows that the term 'combination' carries as a rule a much more narrow and exclusive meaning than the word 'co-operation.' We speak, for example, of Trade Combines or

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Combinations, of Combinations of Workmen, and Combinations of Masters, for a special and somewhat narrow purpose. The object, however, of organisation, strategy, tactics, and discipline is the 'co-operation' of all arms and branches of the Service with one will to attain the great national end in view, that is victory. It seems unfortunate that the combinations of the Services should be dealt with in too purely a mechanical sense, when it is possible to put a little spirit into the instructions concerning them.

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*No. I COMPANY, Ist (BENGAL) SAPPERS AND MINERS, IN KULU, 1905.**

By Capt. J. Charteris, R.E.

The earthquake which occurred in April, 1905, caused a large amount of damage to the Simla-Sultanpur road and to the local roads in the Kulu District.

The principal damages were the destruction of the Duff-Dunbar Bridge, a structure erected at a cost of Rs.125,000 in 1885, and a very extensive landslip at Burwah, which destroyed about a mile of road and buried the bridge by which the road from Simla crossed at this point from the left to the right bank of the Thirtan River.

At the time of the earthquake, No. 1 Company had been detailed to work on the Hindustan-Thibet Road. But, at the request of the Chief Engineer, Public Works Department, Punjab, their destination was changed to Kulu, and all preparations were made for the Company to proceed there in May. Considerable delay occurred in arranging the terms of employment, and consequently the departure was deferred until the 16th June, by which date the terms had been laid down by the Military Department and accepted by the Civil Government of the Punjab.

The terms finally settled were briefly as follows :—

The Civil Government to pay :—(1) ¾ rates of working pay to N.C.O.s and Sappers when on the march to and from the site of work, and for days between the date of departure from and the date of arrival at Roorkee on which the men were not employed on work.

(2). Full working pay for days on which the men were employed on works to N.C.O.s and Sappers, and throughout to Native Officers, and full engineer pay to British N.C.O.s.

(3). Compensation for dearness of provisions, extra warm clothing, hutting, conservancy and water supply charges, tools, etc. required for the work ; and the cost of all fair wear and tear to the Company equipment.

These terms were, I think, very fair, and proved very satisfactory both to the employer and the employed. As will be seen from the statement of accounts attached, the only charges made against the Civil Government on account of para. 3 of the terms of employment were for compensation for dearness of provisions and Rs.4-13-11 per man for clothing. These charges and the full rates of working pay

* Communicated by the Commandant, 1st Sappers and Miners.

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gave the men a slight pecuniary advantage from the work. On the other hand the work done was completed at a much smaller cost than that which the P.W.D. would have had to bear if the work had been done by civil labour under the conditions prevailing in Kulu at the time.

The terms, however, threw upon the O.C. of the Company the task of arranging for his own transport for the march and for the rations of the Company during its stay in Kulu; and as the earthquake, by destroying practically all the houses in Kulu in which the supplies were stored, had produced a state of famine in the country, the latter task involved a considerable amount of work. Rations had to be collected from districts which had been less severely affected by the earthquake, over country tracks the difficulties of which, at all times considerable, had been greatly increased by the innumerable landslips.

It was eventually decided to take from Simla one month's supply for the men, and to trust to local supplies for the rations of the equipment mules and the 204 country mules which formed the transport of the Company on the march.

The O.C. of the Company, Capt. Charteris, R.E., proceeded on the 10th of June to Simla to arrange for transport and the month's supply of rations, and the Company under the charge of a Native Officer joined him there on the 16th June. Lieut. H. J. Elles, Company Officer, was on special duty at Delhi; and as the Corps was under its establishment in British Officers, no other British Officer could be spared from headquarters at Roorkee.

The Civil Authorities had requested that the Company should first attempt to salvage the Duff-Dunbar Bridge. As the direct road to this over the Jalori Pass was reported to be impracticable, the Company proceeded *viâ* Suket and Mandi, and by making double marches throughout reached the site of work on the 26th June.

SALVAGE OF THE DUFF-DUNBAR BRIDGE.

The bridge which had been destroyed was a suspension bridge of 305-ft. span; the up and down-stream cables were each formed of four 9-in. steel wire ropes; the piers were stone in lime pillars, each 15 ft. by 9 ft. in cross section, and connected by a brick in lime arch over the roadway. The upper and lower booms in the girder were of 12 in. by 12 in. timber; and the roadway weighed 600 lbs. per foot-run of the bridge.

Fracture had taken place in the piers immediately below the arch. The masonry above on both banks had fallen forward into the river bed and the cables had dropped transversely across the roadway; thus the up-stream cable was lying up stream of the remains of the pier on the right bank and in the road between the piers on the left bank, and the down-stream cable in a corresponding position.

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The anchorages had not been damaged. The superstructure of the bridge was lying in the river and still secured by the slings to the cables.

There is no doubt that the destruction of the bridge was due to bad masonry in the piers. The mortar used had disintegrated and gave off clouds of dust from the remains of the pier at the least breath of wind; the inside of the piers, as far as could be judged, had been made from the remains of boulders from the river bed thrown into a bed of mortar; there was no bonding.

Before the arrival of the Company, the local Sub-Division Officer, P.W.D., had attempted to raise the cables by wedging logs underneath them. The Company commenced work on the 28th June. The method adopted was to raise one 9-in. rope at the pier by means of screw jacks to a height of one foot above the 9-in. ropes of the cable of which it formed part, and then to pull sheers underneath the rope as far out in the river as the men could work, and then sever the clips which secured this rope to the remainder of the cable; the jacking was then continued as far as the jack would lift the cable, and the process continued.

A traveller on a 3-in. wire rope was put across the river to enable work to be carried on on both banks; and as the cable appeared it was secured by differential tackle to this rope, and at the same time was secured up stream by a 3-in. wire rope.

By the 7th July, one 9-in. rope had been raised on to scaffolding 17 ft. high on the right bank and 12 ft. high on the left bank, and men working on the cable in the water had been able to sever all the clips; a 3-in. steel wire rope was then secured by clips and taken over sheers to a winch, and the 9-in. wire rope was pulled clear of the water. With one 9-in. wire rope secured above the water the remainder of the wire ropes of the cable presented no difficulty. Each was jacked up separately to the top of the scaffolding and then drawn out of the water.

In the meantime sanction had been applied for to erect a new and lighter bridge across the river. As only four 9-in. wire ropes were required for this, it was decided to cast the down-stream cable loose on the left bank and endeavour to draw the loose ends across to the right bank. After the up-stream cable had been raised a large amount of the roadway had been broken apart from the down-stream cable by a heavy flood, and from the flow of the river it was estimated that not more than 160 ft. of roadway remained attached to the down-stream cable. This estimate subsequently proved too small.

A calculated weight of 12 tons of wood, which it was estimated would suffice to float the end of the cable and by the force of the water keep it fairly taut and prevent it fouling the rocks in the river bed, was securely wired to the cable close to the anchorage. A 3-in.

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steel wire hawser was secured to this float, and was taken across the river to a winch which had been put up at a distance equal to the span down stream of the pier on the right bank. On casting loose from the anchorage the wooden float came across to about three-quarters of the distance, but at this point the cable fouled some large rocks and the pressure of the water caused the float to sink. Eventually the cable had to be overhauled from the right bank and men were sent out on rafts to lift it by grapnels over the rocks on which it had fouled. It would have been an advantage to have secured light buoys with long lines to the cable at intervals before casting loose, to enable the place where it fouled to be judged.

BHUNTAR TEMPORARY BRIDGE.

On the 26th July, on the day that the salvage work was completed, sanction was received to construct the temporary bridge. On the same day a party of men was sent to cut the necessary trees for the woodwork, and the iron work was commenced. The bridge was opened to traffic on the 12th August, and completed on the 19th August. The work was delayed by the small quantity of blacksmith's tools available. The P.W.D. were unable to provide any; and as every bolt and nut had to be threaded by the two boxes of stocks and dies in the equipment of the Company, and as every spike and dog had to be made up out of the raw iron, the blacksmiths could not turn out the iron work as quickly as it was required, although they were kept at work 12 hours each day including Sundays. Had it been possible to purchase bolts, nuts, dogs, and spikes, I think the bridge would have been completed in 8 working days. It is to be remembered, however, that the time taken does not represent the erection of the bridge only, but also the felling of the trees required for the woodwork and their transport from the forest to the site, a distance of 2½ miles over very rough ground, the sawing of the chesses, etc.; and that, owing to one section of the Company being detailed for other work and a detachment having been left at headquarters at Roorkee, not more than a half Company was actually available for this work.

Plate I. shows the bridge erected. It is worth noting that the bridge was extremely stiff. This I attribute to the very slight dip (1 in 20) and to the large horizontal splay given to the cables (from 14 ft. over the piers to 7 ft. at the centre).

DAMAN TEMPORARY BRIDGE.

On the 17th July, one section under a N.O. and the senior British N.C.O. of the Company, was detached to assist the P.W.D. in the erection of a bridge at Daman, 19 miles distant, to replace the bridge at Burwah which had been destroyed by the earthquake. The

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original idea for the bridge to be constructed was a cantilever bridge from dry stone masonry piers across a span of 90 ft. with two small spans of 20 ft. each on the shore side of either pier. Both the design and the site were the choice of the P.W.D. The piers were designed to be 32 ft. above foundation level, a dangerous height at which to put the strain of the cantilevers on a dry stone masonry pier; and the pier on the left bank was, owing to a sharp bend in the river immediately above the bridge, precisely in the fairway of any trees brought down the river when swollen by flood. For these reasons the design did not appear to be suitable; but as orders had been given work was commenced, and by 10th August the piers on the right and left bank had been raised to a height of 16 ft. 6 in. and 5 ft. respectively, with a cross section of 18 ft. by 15 ft. and a cut water up stream.

On the 11th August, heavy rains brought down a 14-ft. flood; and on the 12th, when the flood subsided, no vestige of either pier remained. As a small temporary bridge, which was the only means of crossing the river, had also been destroyed, work was commenced without reference on a new site with a span of 140 ft. As the 3-in. wire cables which had been used in the salvage work at the Duff-Dunbar Bridge were now available, it was decided to make a combined suspension, tension, and cantilever bridge (*Plate* II.). The bridge was completed on 7th September; drawings of this bridge are attached.

The ropes available for the cables were 3-in. steel wire ropes with hemp cores. Great difficulty was experienced in adjusting the dip, owing to the stretching of the ropes. The cables were first placed at a dip of 2 ft. 6 in. above the required dip, and the roadway temporarily placed in position. During 24 hours the cables stretched sufficiently to lower the centre transom 6 in. below the required dip. The roadway was taken up and the cables pulled through a further 9-in. dip, but again stretched. Eventually, after four adjustments, the roadway was made to the correct dip, but the bridge will undoubtedly distort under traffic and will not be satisfactory.

REMARKS ON SUSPENSION BRIDGES.

The only points of interest that have come to notice in the bridging work are :—

(i.). The unsuitability of hemp core steel wire ropes for cables in suspension bridges.

(ii.). The extra stiffness that is obtained by giving a deep horizontal splay to the cables.

(iii.). The advantage of passing the roadway over the cables at the centre, both from the point of view of simplicity and hence rapidity of construction and from that of stiffness.

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With reference to this latter point a certain amount of waterway is lost at the centre, but I do not think this is of importance. In almost all sites for bridges in the hills the flow of water sets either towards one bank or the other, and logs and trees brought down by floods seldom take their course in the middle of the waterway.

If round iron is available it is, I think, much more suitable for slings than wire rope. It does not stretch, calculated lengths can be laid off exactly, and any subsequent adjustment can be easily made by a screw thread.

REMARKS ON COMPANY EQUIPMENT AND STRENGTH.

With reference to the equipment of the Company the following points came to notice :—

(i.). The metal blocks are unsuitable for working a 3-in. wire rope or a new 3-in. manilla rope.

(ii.). There is no ratchet plant for boring holes in metal ; this has to be improvised, and time is lost.

(iii.). The compound-lever wire cutters broke in the course of one day's work cutting ordinary telegraph wire.

(iv.). The mason's hammers are too light for stone work.

(v.). The books carried in the survey boxes are unsuitable. A Molesworth, an R.E. Field Service Pocket Book, and a Trautwine should be substituted for the Chambers' Tables and the Auxiliary Tables. I would also recommend the substitution of an Abney's pocket level for the De Lisle level.

(vi.). Some means of reproducing plans would effect a great saving of time to the Officers in departmental work. Generally six or seven copies of each design are required, including those to be submitted to the Department concerned, those kept for record, and working drawings.

Throughout the whole of the work, the Company was severely handicapped by the absence of the Subaltern Officer. I am strongly of opinion that no Company should be sent on detached work at any distance from headquarters without its full peace complement of Officers. On such work the Company is almost invariably split up, and the detachments are generally at such a distance that it is impossible to visit all their work in the same day. In addition to the supervision of engineering work there is almost always the extra duty of arranging for rations, a very largely increased correspondence, and dealings with other departments, which the O.C. Company cannot leave to any British N.C.O. The economical employment of Sapper Companies on public works is only effected by very close supervision

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and by the general arrangements, in which no N.O. or British N.C.O. can replace an Officer; and it is, I think, very essential that there should be some one ready to take the place of the O.C. Company should he be incapacitated from work.

REMARKS ON EMPLOYMENT OF SAPPER COMPANIES ON PUBLIC WORKS.

With regard to the general question of the employment of Sapper Companies on public work, it will not, I think, be found an economy for a department to employ a Company in preference to local labour on road work, except in places where much rock work is required; in ordinary hill road making, the supervision which the organisation of a Sapper Company enables it to exert is not required, and the cost of the supervising establishment is not repaid by its work.

In bridge making, and in places where labour has to be imported and rations arranged for by the employing department, Sapper labour will usually be an economy. In any work on which a Sapper Company is employed, it will be found an economy to give the O.C. a free hand regarding the employment of any civil labour he can procure. There is in every work a large amount of unskilled labour which can be done cheaper by coolies than by Sappers. The organisation of a Sapper Company is devised for field service, and a considerable number of trades are necessarily represented in its small establishment. The proportion of the tradesmen is arranged to meet the contingencies of field service, with the result that in any work the number of men of some one trade will be found too small. To make good this deficiency it is cheaper to employ civil labour than to have nearly the whole Company standing by waiting while the tradesmen of that trade overtake the work of the rest of the Company.

With reference to the question of terms of employment, the existing rules regarding contract work, whereby the O.C. Company has to pay the cost of moving the Company to and from the site of work and all incidental charges, are detrimental to the chances of Companies taking up contracts at any distance from their station. The O.C. has naturally to protect his men. The contract offered to him must necessarily often be for work at a place of whose local conditions he is entirely ignorant. He has to make a guess at the probable cost of transport of rations from wherever they may be obtainable to his camp (possibly even at the initial cost of the rations); also a guess at the nature of the ground on which his work is to be; and an estimate of the time it will take him to complete his contract, and the consequent saving per month he must effect to cover the transport of his Company to and from the work. When to this he has added a large margin to cover possible contingencies, he will not often find himself in a position to accept a contract.

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It is, of course, unreasonable to expect departmental authorities to ask for a Sapper Company, of both the capabilities and cost of which they are probably ignorant, on any other terms than contract terms, until all other means have failed. I would suggest that the military authorities should pay the compensation for rations and the cost of transport; and that the Company should refund to the military authorities the difference between the amount earned by their contract and the full rates of working pay, provided the former is the greater of these sums, up to a limit of the cost of transport.

The risk then lies with the military authorities; and as there is no doubt that a month on works is better training for both officers and men than a year in cantonments, it is fair that the military authorities should be liable to a proportion of the cost involved. But as during the time of the employment of the Company its working pay is not a charge on the military estimates, it would rarely happen that they would be losers by a Company proceeding on contract work on these terms.

The following Table shows the expenditure involved in the various works executed by the Company and in the move to and from Kulu :—

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ABSTRACT OF ACCOUNTS OF WORK IN KULU.

Item.	Salvage Work.	New Bridge Bhuntar.	New Bridge Daman.	Road Work Daman.	Move to Kulu.	Move from Kulu.	Miscellaneous.	Remarks.
	R. A. P.	R. A. P.	R. A. P.	R. A. P.	R. A. P.	R. A. P.	R. A. P.	
Working Pay—								
June	—	—	8 0 3	—	391 15 6	—	—	
July	1,018 11 6	—	—	—	—	—	—	
August	—	424 7 9	594 0 9	—	—	—	—	
September	—	—	124 5 0	151 13 6	—	398 8 6	—	
Compensation for Provisions—								
June	—	—	—	—	123 2 4	—	—	
July	235 6 0	—	—	—	—	—	—	
August	—	105 15 8	58 5 2	—	—	—	—	
September	—	—	—	51 9 10	—	154 13 7	—	
Transport Charges	154 12 0	2 1 0	340 5 9	1 9 0	1,859 3 0	2,351 12 6*	—	* Estimate.
Purchase of Stores	476 1 3	303 13 3	621 12 0	—	—	—	—	
Local Labour	555 10 6	395 9 0	345 10 6	—	—	—	753 4 6†	† A.R. paid for Ex. En.
Repair Camp Equipment	—	—	—	—	—	—	5 1 0	
Repair Equipment	—	—	—	—	—	—	0 2 0	
Military Allowances	100 8 0	38 13 3	91 12 9	12 8 0	46 8 0	48 15 6	—	
Telegrams	72 8 0	—	82 12 0	—	—	18 3 0	—	
Travelling Allowances	—	—	95 3 8	—	26 0 0	4 8 1	—	
Supervising Allowance	72 0 0	38 0 0	24 0 0	20 0 0	—	—	—	
Miscellaneous	—	—	—	—	7 10 6	—	786 7 6‡	‡ Clothing Compensation.
Medical Stores	—	14 12 10	12 2 7	—	—	7 10 10	56 4 0	
Total	2,685 9 3	1,323 8 9	2,398 6 5	237 8 4	2,454 7 4	2,984 8 0	1,601 3 0	

N.B.—Transport Charges of move do not include Railway Charges, which are adjusted by book transaction between the departments.

Cost of repairs and renewals to Engineer Equipment is not included, as this charge is also met by book transaction.

The cost of the Daman Bridge is high, owing to the large amount of masonry in the abutment. A suspension bridge of larger span would have been cheaper, had cables been available.

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EFFECT OF MAGNETISED FORAGE CAPS ON PRISMATIC COMPASSES.

By Capt. F. M. Close, R.E.

Having occasion to do some prismatic compass sketching in Bermuda, I found the magnetic declination as observed by me to be very different to what was expected. I traced the discrepancy to the iron wire which stiffens the rim of my forage cap. For purposes of check I took a round of angles with Lieut. A. L. Owen, R.E., the results of which are appended.

It will be seen that a prismatic compass sketch could not possibly be carried out with any reasonable accuracy by an officer wearing a cap in a condition similar to mine; and my experience may be useful to others.

No doubt both Lieut. Owen's cap and mine have become magnetised owing to our constant work in dynamo rooms, for no appreciable error was discovered in tests with new caps out of the clothing store; and evidently only caps that have been near dynamos or other electric light gear are sufficiently magnetised to matter.

I submit that no stiffening wire should be allowed in these caps, or that, if allowed, the wire should be non-magnetic, such as copper or brass. This of course applies specially to R.E. officers.

ERRORS INTRODUCED IN PRISMATIC COMPASS BEARINGS

BY WEARING FORAGE CAPS STIFFENED WITH STEEL WIRE RIMS WHICH HAVE BECOME MAGNETISED DURING E.L. PRACTICE.

Object.	Bearing taken by Lieut. Owen, R.E.		Bearing taken by Capt. Close, R.E.		Error with Cap on. Lieut. Owen.	Error with Cap on. Capt. Close.	Remarks.
	Cap on.	Cap off.	Cap on.	Cap off.			
1. Door of Oil Store...	344°	360°	5½°	359½°	16° W	6° E	Both caps have rim wires strongly magnetised, due to officers being employed on E. L. duties. Two poles in Capt. Close's cap; four in Lieut. Owen's.
2. Flagstaff	61°	48½°	49°	47½°	11½° E	1½° E	
3. Telegraph Post.....	99½°	90½°	84½°	90½°	9° E	6° W	
4. Edge of House	140°	144½°	135°	145°	4½° W	10° W	
5. End of Gunshed ...	166½°	181°	173½°	181°	14½° W	6½° W	
6. Gable of Church ...	194½°	208½°	207°	209°	14° W	2° W	
7. Chimney, Mt. Erie	234°	246½°	252°	247½°	12½° W	4½° E	
8. Scaffold Pole	316°	311½°	323°	311°	4½° E	12° E	
9. Rain Water Pipe ...	327°	327°	340°	327°	0°	13° E	

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THE DIRECT CURRENT 3-WIRE SYSTEM.

By MAJOR F. BAYLAY, R.E.

THE results recorded below refer to a series of observations made at the Electrical School, S.M.E., upon an experimental circuit arranged to represent a D.C. 3-wire system, having one main generator across the "outers" and one electrically driven "balancer."

It may be desirable to remark that a D.C. balancer consists of two similar machines mechanically coupled together; and that this combination may be driven by a steam engine, thus forming a "steam-driven balancer," or may be self-driving. Both methods are common in practice. When steam driven, both machines may be acting as generators; but if self-driving, one, at least, of the machines is acting as a motor, and the other machine may then be acting as a generator or may be running light according to the actual want of "balance" on the system. If the system is in balance, then both machines would be motoring in the case of a self-driving or, as it is more generally called, an electrically driven balancer. The machines forming the balancer may be, and generally are, simply shunt wound, or they may be compound wound. In the latter case the compound winding is so arranged that it acts cumulatively or in the same sense as the shunt winding of that machine which happens to be generating, and differentially in the case of the machine which is motoring.

Compound-wound balancers are rarely used in practice, since they are very apt to become unstable if run in parallel with any other balancing apparatus (*e.g.*, in parallel with a steam-driven balancer or secondary battery). The advantage claimed for a compound-wound balancer is that it can automatically adjust the voltage upon the two sides of the system, whereas the shunt-wound balancer needs to be adjusted by hand.

The fields of a shunt-wound balancer may be "cross connected" or "direct connected." If we identify the two machines as positive and negative, then in any case the armature of the positive machine would be connected between the positive and neutral wires of the system, and the armature of the negative machine between the neutral and negative wires of the system. If cross connected, the field of the positive machine would be connected between the neutral and negative wires of the system and the field of the negative machine between the positive and neutral wires. If direct connected, the fields would be connected similarly to the armature.

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Theoretically a balancer may be connected to the system either at the generating station or close to the "feeding-point." When the loads upon the two sides of a 3-wire system are unequal there is a very strong tendency for the voltage across the less heavily loaded side to exceed that across the more heavily loaded side. This want of balance of course occurs at the points of consumption; and since the object of the balancer is to correct the irregularities in voltage produced, it is obviously desirable to let the remedy "touch the spot" if possible. The feeding point is as near "the spot" as it is practicable to get, but even so the balancer is, as a matter of fact, always installed in the generating station so that it can be under supervision. However, bearing in mind the tendency of a shunt-wound motor to increase its speed as its field is weakened, a brief consideration will make it clear that a shunt-wound balancer installed at the feeding point with cross-connected fields would be to a certain extent self-regulating, whereas with the fields direct connected it would not be self-regulating at all wherever it was installed.

It is to be remembered that means are provided to enable the staff of the generating station to ascertain the voltage across the outers at the feeding points, and this voltage may be kept constant. If, as is often the case, the voltage across each side of the system at the feeding points is indicated at the generating station, it may be possible not only to keep the voltage across the outers constant, but also to keep the voltage across each side of the system constant, provided the range of the balancing apparatus is sufficient to deal with the maximum want of balance that occurs.

As regards the experimental circuit already referred to, the main generator consisted of a motor-driven 200/250-volt 25-ampère shunt-wound machine with field-regulating resistance. The balancer consisted of two shunt-wound machines mechanically coupled each with a similar field-regulating resistance. These two machines were similar, each being a 115-volt ⅜rds B.H.P. motor; resistance of shunt coil (cold) 14 ohms; resistance of field-regulating resistance "all in" (cold) 14 ohms. Assuming an efficiency of 70% for each motor, the full load current would be 7·1 ampères, which gives an idea as to the limiting want of balance that the combination could deal with. This balancer could be connected either at the "feeding point" or at the "switchboard" in the "generating station," and the fields could be either cross connected or direct connected. The load on each side consisted of incandescent lamps, the number of which could be varied.

The "feeder" was 3-wire, all conductors of equal size, resistance of each conductor about 0·5 ohms. In order to economize space the feeder actually consisted of three nominally similar coils of iron wire, and of course the resistance of each "wire" of the feeder varied appreciably owing to the heating caused by the current passing through

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it. The voltage at switchboard (S.B.) and at feeding point (F.P.) were read on standard instruments, the remainder of the instruments were only approximately correct. The voltage across the outers at the F.P. was kept constant at 200 volts.

The figure shows diagrammatically the arrangement of the circuit when the balancer was connected at S.B. with fields direct. The modifications necessary in the diagram to represent the other methods of connection can be readily conceived.

Referring now to the table of results;—column 1 shows the position and manner of connection of the balancer; column 3 should equal the sum of columns 8 and 13; column 4 is the sum of columns 9 and 14; columns 6 and 11 show what the load in ampères on each side should have been corresponding to the number of lamps switched on, if the voltage had been correct; column 12 equals approximately the sum of columns 7 and 15; column 15 should equal the sum of columns 16 and 17 very nearly. The currents in the fields of the balancer were not separately recorded; hence it is not possible to connect the ampères in column 2 with those in the other columns.

Set 1 refers to balanced loads, and calls for no special comment except that, after the balancer had been got running correctly for Set 1, the results of Set 2 were obtained by making the loads uneven, correcting the voltage across the outers at F.P. by varying the excitation of main generator, but balancer fields were not altered at all. Hence Set 2 shows the extent to which the balancer was automatic. In this set and in the case of Set 4 the limiting difference of voltage between the two sides of the system was arbitrarily fixed at 20 volts, the number of lamps across the negative side was kept at 14, and the number across the positive side decreased until the limiting difference of voltage was reached (as near as possible). Set 3 shows the limiting want of balance which the balancer could correct for—a limiting current of 13 ampères in the middle wire was decided upon. A further limit was that one of the two machines should have no added resistance in its field circuit; this is a limit which would occur in practice just as much as the limiting current in the middle wire. Set 4 followed Set 3 in exactly the same way as Set 2 followed Set 1. With balancer connections X.F.P. no further readings could be taken in this set, since the balancer could actually correct the voltage with the limiting current flowing in the middle wire (*vide* first series of readings in Set 3).

Although the plant experimented with was small, the result in the table may be taken as correctly typical of what can be expected from a balancer; and so far as is known no similar results have heretofore been published.

The value of the balancer when connected to the system at the feeding point is clearly shown to be considerably greater than when

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connected at the switchboard ; evidently, the higher the resistance of the feeder the more this difference would become marked. The advantage of the cross-connected fields is also clearly shown. Indeed it is thought that the table of results forms practically a chapter upon electrical engineering for those who can read the language.

It is a most interesting and instructive exercise to draw a fall of potential diagram for each series of the " out of balance " readings recorded in the table. It may be safely predicted that anyone who correctly does this will know more about the action of a balancer on a 3-wire D.C. system than he ever did before !

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CONNECTIONS.	MAIN GENERATOR.			POSITIVE SIDE.					NEGATIVE SIDE.					BALANCER.		
	Amps.	Volts.		Lamps.		Amps. load actual.	Volts.		Lamps.		Amps. load actual.	Volts.		Ampères.		
		At S.B.	At F.P.	No.	Amps. at 100 v.		At S.B.	At F.P.	No.	Amps. at 100 v.		At S.B.	At F.P.	Mid. wire.	+ve arm.	−ve arm.
1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
SET 1. BALANCE. VOLTAGE CORRECT.																
N.B.	22·5	226	200	14	22·5	22·5	113·5	100	14	22·5	22·5	113·5	100	No Balancer.		
X.F.P.	24·5	229	203	14	22·5	22·5	114	100	14	22·5	22·5	115	100	0	1·2	−1·2
X.S.B.	24·5	224	200	14	22·5	22·5	112	100	14	22·5	22·5	112	100	0	1·5	−1·5
11.F.P.	24·5	226	200	14	22·5	22·5	112·5	100	14	22·5	22·5	113	100	0	1·2	−1·2
11.S.B	24·5	227	200	14	22·5	22·5	113·5	100	14	22·5	22·5	113·5	100	0	1·3	−1·3.
SET 2. OUT OF BALANCE. BALANCER FIELDS NOT ALTERED. VOLTAGE WRONG.																
N.B.	21	224	200	12	19·25	21	119·5	108	14	22·5	21	105	92	No Balancer.		
X.F.P.	18	219	200	6	9·75	11	118·5	109	14	22·5	20·5	101	91	9·7	6·1	3·6
X.S.B.	19·5	219	200	8	13·0	14·5	115	110	14	22·5	20·25	104·5	90	6·0	4·2	1·7
11.F.P.	19·5	220	200	8	13·0	14·5	120	110	14	22·5	20·5	100	90	6·0	3·9	1·7
11.S.B.	20·25	222	200	10	16·25	17·5	116	108	14	22·5	20·75	106	92	3·3	2·8	0·4
SET 3. OUT OF BALANCE. VOLTAGE CORRECTED BY ADJUSTMENT OF BALANCER FIELDS.																
X.F.P.	19·5	221	200	6	9·75	10	110·5	100	14	22·5	22·5	111	100	12·6	8·4	4·0
X.S.B.	21·0	221	200	9	14·75	14·75	104·0	100·5	14	22·5	22·5	117	99·5	7·75	5·5	2·0
11.F.P.	21·0	224	203	9	14·75	14·75	111·5	100	14	22·5	22·5	112	100	8·2	5·9	2·4
11.S.B.	22·0	222	200	10	16·25	16·25	106	100	14	22·5	22·5	116·5	100	6·6	5·2	1·6
SET 4. OUT OF BALANCE BEYOND CONTROL OF BALANCER. BALANCER FIELDS AS IN SET 3.																
X.S.B.	17·5	215	200	4	6·5	7·5	105	108·5	14	22·5	20·5	110	91·5	13·0	8·9	4·1
11.F.P.	17·0	217	200	4	6·5	7·5	118	109·5	14	22·5	20·5	99·5	90·5	13·0	8·5	4·7
11.S.B.	18·5	217	200	6	9·75	11	109·5	109	14	22·5	20·5	108	91	9·8	6·9	3·0

Reference to abbreviations in Column 1 :—

N.B. signifies that the "balancer" was not connected to the circuit at all.

X. signifies that the fields of the balancer were cross connected.

11. signifies that the fields of the balancer were direct connected.

S.B. signifies that the balancer was connected to the system at the switchboard.

F.P. signifies that the balancer was connected to the system at the feeding point.

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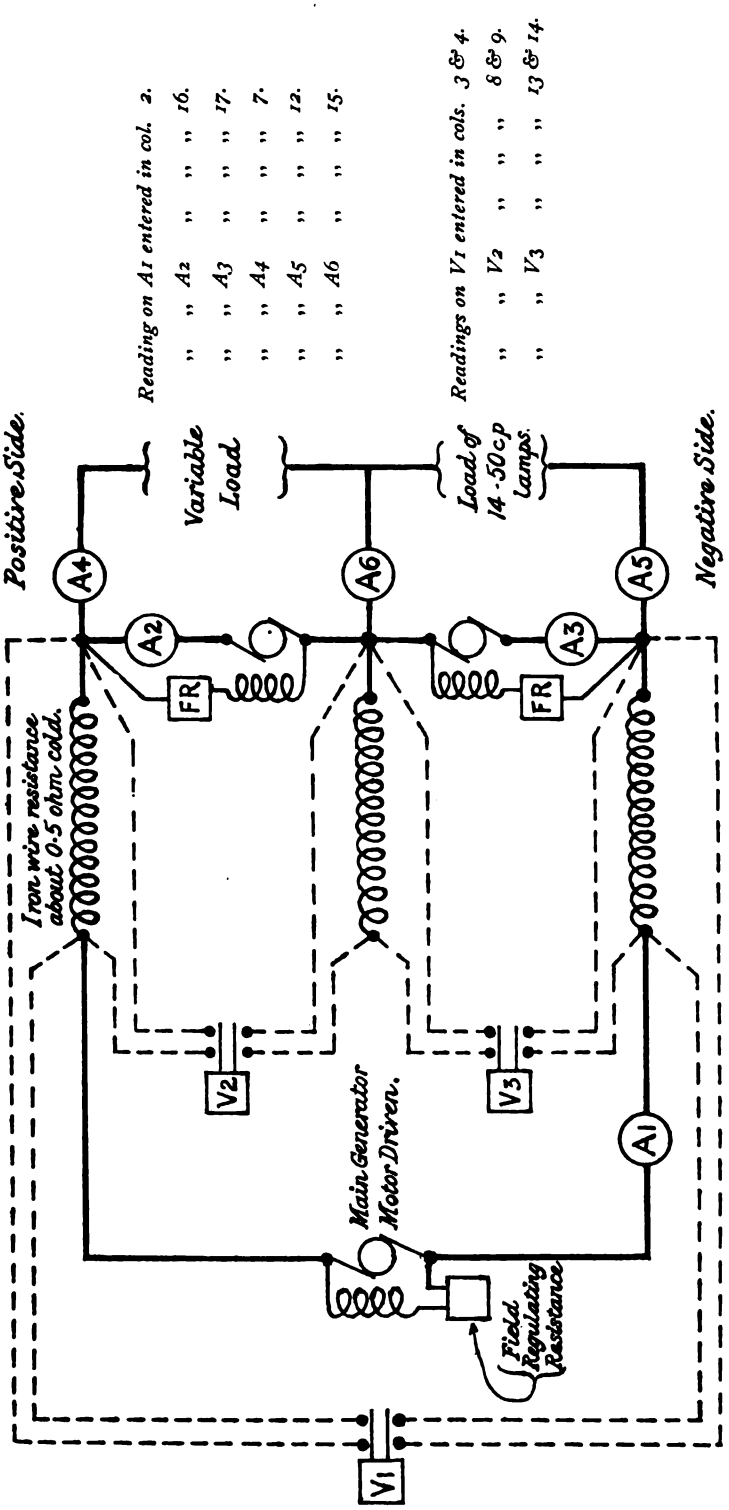
Positive Side.
Negative Side.
Reading on A1 entered in col. 2.
" " A2 " " " 16.
" " A3 " " " 17.
" " A4 " " " 7.
" " A5 " " " 12.
" " A6 " " " 15.
Variable Load
Load of 14 - 50 c.p lamps.
Readings on V1 entered in cols. 3 & 4.
" " V2 " " " 8 & 9.
" " V3 " " " 13 & 14.
A4
A2
A6
A3
A5
A1
FR
FR
Iron wire resistance about 0.5 ohm cold.
V2
V3
V1
Main Generator Motor Driven.
Field Regulating Resistance

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THE SIEGE OF SEBASTOPOL:

Some Conversations with General Todleben and Sir John Burgoyne.

By Major-Gen. Hon. G. Wrottesley, late R.E.

The correspondence of the Duke of Cambridge, recently published in Col. Willoughby Verner's Military Life of His Royal Highness, contains a letter from Lord Wolseley, written in 1894, on the subject of the Siege of Sebastopol, which revives a long-forgotten controversy. It appears that Lord Wolseley having announced his intention of revisiting Sebastopol, the Duke asked him to examine the ground on both sides of the Harbour and give his opinion on the question which had been mooted about that time—whether, after all, the flank march had not been a mistake, and whether the Allies would not have done better by attacking the Forts on the north side of the Harbour. In reply to this request by the Duke, Lord Wolseley wrote a letter which will be found at p. 384, Volume II., of the book referred to.

In this letter Lord Wolseley expresses an opinion against an attack on the north Forts, on the ground that there was no harbour on that side, but does not enter upon the question as to whether the capture of these Forts would have been of any advantage to the Allies. He writes, however, that in his opinion the English might have taken possession of the south side of the place on the day of the flank march; and he adds "I may be wrong, but I have always in my own mind blamed Sir John Burgoyne for this delay, and for our not having taken Sebastopol on the south of the Harbour the morning after we had crossed the Tchernaya river."

I was not with Sir John Burgoyne in the Crimea, having been invalided from Varna shortly before the expedition set sail. After my arrival in London in November, 1854, I found there was a strong feeling against him in the military clubs, where it was said that he had prevented an assault upon the place in order to have a siege for the Engineers. It was impossible to combat such notions at the time—the outcry against the Generals was too violent; but I was in hopes they would have disappeared after I had published his "Life and Correspondence" in 1873.

It is now well known that Sir John himself was the author of the flank march; and in conversation he has told me that he fully expected the Russians would have been so taken by surprise

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that the Allies might have been able to occupy the place as suggested by Lord Wolseley. During the flank march he proposed to Lord Raglan to summon the garrison; this was not done, owing probably to the illness of the French Marshal, St. Arnaud, who was at that time at the point of death and quite unable to attend to any business. Such a summons must have been in writing and signed by both Commanders-in-Chief; no notice would have been taken of a verbal message by any Russian officer in a responsible position. Sir John had had a previous experience of this kind; for when he was sent by Lord Wellington to summon the garrison of the Retiro at Madrid in 1812, the French officer in command of the place was very indignant at a verbal message having been sent to him, and loftily replied "*Les Français ne se rendent pas si facilement.*"

At the time this summons would have reached the garrison, Korniloff had not ferried over the Russian forces from the north side; and Sir John always thought a great opportunity had been lost, as there was every chance that the place might have been surrendered to us at that time owing to the paucity of the garrison.

This seems also to have been the opinion of Todleben. When the great Russian Engineer was in England, some time about 1864, enquiring into our application of iron to coast batteries, I was attached to him officially, and he spoke to me very freely on the subject of the siege. He appeared in fact to have taken a liking to me and on leaving offered to obtain for me a Russian decoration, which I declined with thanks as I should not have been allowed to wear it. The result, however, was that I have been on the most confidential terms with the two chief actors in the siege, and heard a very complete story of it from two opposite quarters.

Todleben was in charge of the defences of the Karabelnaia suburb, opposite to the English; and his opinion was that we might have occupied it when we first arrived before it, owing to the incomplete state of the defences; on the extreme left of the position in fact there were no works at all. This agrees with the account of the position given by Sir G. Cathcart, who sent Lieut. Ravenhill, R.E., to Sir John Burgoyne with a letter stating that, if he was supplied with some additional guns, he could occupy it with the Fourth Division alone. This was on the afternoon of the flank march. Lieut. Ravenhill however did not reach Sir John Burgoyne till between 8 p.m. and 9 p.m. on that evening, as the Headquarters had moved on to Balaklava. According to Lieut. Ravenhill's account of his mission, Sir John's answer to him was, "At any rate the French must be consulted first"; and he left the letter with him and returned to Sir George Cathcart. What became of that letter I never could discover; it was not amongst Sir John's papers when he returned to England, and I've no doubt he sent it on to Colonel Steele, the Military Secretary, or to Sir R. Airey, the Quartermaster-General.

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Before the following morning the Russians had moved a very large force across the Harbour, and the place appeared to swarm with troops when Sir John saw it on that day for the first time. In front of the English, the Malakoff Tower was intact and mounted several guns. On the French side, the Dockyard was surrounded by a crenellated wall. In front of all these masonry defences there were earthworks mounting heavy guns. The masonry defences were, however, the main obstacle to an assault, whilst, on the other hand, they could be easily destroyed by a cannonade from a distance, and we had a fine battering train just outside the Harbour of Balaklava. No General would have been justified in hazarding an assault under these circumstances; but as a matter of fact Sir John was never asked his opinion on the subject; it was tacitly assumed by everybody at Headquarters, both French and English, that it would be necessary to cannonade the place before an assault was delivered.

After the publication of Kingslake's history of the campaign, in which he states that Lord Raglan had proposed to take the place by a *coup de main*, but had been prevented by the refusal of the French General, added to objections raised by Sir John Burgoyne, I began to think that perhaps Sir John's memory had been at fault, and I pressed him strongly on the subject. He was very positive that no suggestion of the sort had ever come before him, but to make the matter sure I suggested that he should write to General Canrobert on the subject. Canrobert's reply will be found in the "Life and Correspondence of Sir John Burgoyne"; he states explicitly that Lord Raglan had not proposed to assault the place immediately after the arrival of the Allies before it.

On another occasion Todleben said to me "Abroad they give me all the credit for the defence of Sebastopol, but the person who really saved the place was Admiral Korniloff, who ferried over the whole Russian army in so short a time: he was a splendid fellow, was Korniloff, but he was killed early in the siege." It would appear by this that Todleben considered the place safe as soon as the Russian forces had been brought over to the south side. If this was the case, there is not so much divergence between his views and those of Sir John Burgoyne as would appear at first sight; for the latter, in his first memorandum to the Engineers, printed in the official account of the war, says—"A site must be found for some heavy guns to bear upon the Tower, which seems to be the only obstacle to an assault at any time." This shows that he considered the earthworks at this period to be of small account, as stated both by Todleben and Sir George Cathcart.

There never was any idea amongst the English Engineers of undertaking a regular siege of the place. I can speak positively on this point, for up to a period very shortly antecedent to the embarkation of the troops I was aide-de-camp to Brigadier-General Tylden,

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the Commanding Engineer. Our idea was the old Peninsular one of erecting batteries at a distance, in order to subdue the fire of the place, and then assaulting. This programme was fully carried out, so far as the English Engineers were concerned, for I was told by Todleben that at the date of the first bombardment, in October, he was in charge of the Russian defences opposed to us, that every gun on their works had either been dismounted or silenced, and that we should have probably taken the place if an assault had been made upon it at that time. He said to me, he thought his last hour had come, and he put on all his orders so that his body might be recognised if he fell, and never, at any period of his life, had he felt so relieved as when he saw our troops withdrawn from the trenches on the evening of the 17th of October.

The late Major-General Ewart, who was adjutant of the Engineers and was standing close to Sir John Burgoyne at the time, told me he could see that the latter was bitterly disappointed when the orders arrived for the withdrawal of the troops. This took place, as is well known, in consequence of the failure of the French fire, their brass siege guns having been no match for the heavy ship's guns which had been mounted by the Russians, and which added to the blowing-up of one of their magazines had left the advantage of the first day's fire entirely on the side of the Russians.

It may be assumed, I think, that, if at this juncture the Allied Army had been an homogeneous force, the Karabelnaia suburb would have fallen; and as we know from the sequel, this would have involved the fall of all the defences on the south side of the Harbour. The failure of the operations as first designed arose therefore from the divided command; the whole war in fact, from beginning to end, is an object lesson against undertaking any important military operation with two Commanders-in-Chief of equal rank. But this moral has unfortunately been lost amidst the turmoil of abuse which has been levelled at our Generals, and by the inveterate habit of mankind to seek for a scapegoat for every disaster. There appears, however, to have been in the generals of both armies a lack of that military genius which fires the imagination of soldiers and often leads to great results. If, for instance, the various assaults had been made by combined columns of both armies, the emulation between the two forces would have probably rendered them resistless; and I have been informed by Sir John Burgoyne that this was the last recommendation which he made to Lord Raglan when he left the Crimea in the spring of 1855.

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WITH A 'ROUND-UP' IN ALBERTA.

By Capt. E. N. Mozley, R.E.

Any soldier, who wishes to recall his campaigning life, may be recommended to try a few weeks with the cowboys of Western America. If he is a foxhunter, he will be able, even in the heat of midsummer, to realize many of the pleasures of the 'Sport of Kings.' To an observant sportsman the expedition will afford endless opportunities of enlarging his knowledge of the horse and its rider. The soldier will find himself more or less under active service conditions; and, although he will not attain that modern Holy Grail, a couple of medals, yet he will have fewer chances of disaster. It ought however to be added that if he tries conclusions with the bronco,* he may find that being used as a projectile is almost as unpleasant as being hit by one.

The melancholy interest attaching itself to all dying institutions belongs to the cowboy, or cow-puncher as he prefers to call himself. The advance of that herald of civilization, the barbed wire fence, is making horse and cattle ranching impossible. "You should have been here ten or eleven years ago," they will tell you, "when we could ride 50 miles in a straight line without being stopped; another ten years will see the thing out." Indeed, within 20 miles of a railway, the land is worse wired than the most notorious hunting country in England; you can, however, still get along in parts, where it has not yet paid the settler to buy up his quarter section and enclose it.

Turning to the map of Canada, such open stretches may even now be found through the eastern foothills of the Rockies (between the Red Deer River and the frontier) and in the tract south of the main line of the Canadian Pacific Railway and east of the Calgary-Macleod branch line; there is also good ranching country south of Macleod and Lethbridge. Much of the United States is already, I am told, played out for cattle, partly owing to the burnt condition of the grass in summer. To a traveller coming into Canada from Idaho and Montana the favourable change in the character of the grass and the sudden appearance of large herds is very striking.

It was in the foothills of the Rockies, about 20 to 40 miles west of the Calgary-Macleod Railway, that the writer took a trip last summer. A ranch owner kindly allowed him to join his 'outfit,'

* The unbroken or badly broken Western horse.

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which was rounding up his 8,000 head of cattle in order to brand the calves and ship "beef," as the steers are generally called.

The 'round-up' is by no means a short annual event, as many people imagine. It is continuous from May to December, the whole 'range' being often covered twice in that time. Were it not for this necessity of finding your stock and bringing it to the cattle-trucks, ranching would indeed be a profitable business. Nature sees to it that your property gets a large increase every year, and makes no charge for keep. The 'range' (that is to say the unsettled tract), with the exception of certain districts which individual ranchmen lease from the Government, is free to all men's cattle. But as these may be anywhere in perhaps twenty or thirty thousand square miles, the business of laying hands on them every year is considerable; and, as all the calves have to be branded, all the cattle must be found.

The 'outfit' is uncommonly like a very small Boer commando. The one the writer accompanied consisted of 15 riders, 1 cook, 2 wagons, and 150 horses; this was rather above the average size. Every rider has his string of 8 or 10 horses, which he alone uses. The men are indeed well horsed: but then it must be remembered that they do the work of a squadron of cavalry.

The hours of work are 5 a.m. to 7 p.m., seven days a week, and one relief as night-herd practically every night; and all this is genuine hard work, covering any quantity of ground, and mounted for the most part on half-broken misanthropes. You will rarely meet a man who works as hard and says as little about it as the cowboys.

Their pay is about 40 dollars a month, besides their keep. It seems poor wages in a land where the unskilled labourer gets a dollar and a-half a day. But, although they could earn more money for less work in a dozen other ways, they come back to the range year after year. Nor have you far to look for the secret: partly no doubt it is the roving freedom, on horseback a dozen hours a day; yet the real reason of the love for this life lies, I think, in the absolute independence with which each man works. They have a foreman, it is true; but if he ever gave an order, it was in some hidden code in which neither writing nor speech had any part. The hour to start, the route taken, the rendezvous, and the subdivision of the work were apparently understood by instinct; and during the many incidents of the day there seemed to be an unanimous consent that there was but one natural way of meeting any situation.

If these men were enlisted for war they should be the finest force the world has ever seen. Their work is very like a soldier's. Most of them have learned to take cover while hunting in the mountains; to all of them the knowledge of ground and its use are the rudiments of their profession. A cowboy, without watch or compass, will tell you both the time and the north by the sun with extraordinary accuracy. His powers of observation with eye and ear approach, as

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nearly as is allowed to the white man, those of the Red Indian. He can use a gun: and—rarest of all accomplishments—he can take care of himself. Show him a steer: he will rope, butcher, and cook it as though each art had been his hobby for years. He is veterinary surgeon and farrier (on the rare occasion when the latter is required) to his horses. Moreover is his own doctor; and perhaps it is for this reason that he never goes sick unless he is hurt; if he did, he would be left behind.

This supreme efficiency and spirit is kept up without orders, instruction, or discipline. The cowboy stands out as the ideal fighting man of to-day, who brings his own mother-wit to bear on ultimate situations beyond the law. The British Army could learn much by studying his methods. Ireland, Scotland, Wales, and much of the north and west of England have the requisite training ground, equal in its way to anything in Western America. And we have the men. The glory has not yet departed from Israel. We can still raise in the soldier the spirit of the cowboy (with perhaps slight improvements here and there in the latter's morals). But it will never be done *until the soldier's work is reproductive, until it is something more than mere practising. This* is the great problem, and it is rarely mentioned by our Army Reformers. It is in this that the Royal Engineers have an advantage over the rest of the army; their work has a special use and therefore a dignity. Devise an employment for the Line which, while being allied to soldiering, will be reproductive, and you will again have placed the Army in the front rank of the professions.

But '*à nos moutons*,' or rather cows. Early one morning I was driven to the camp and found only the cook at home; he was armed with a bottle of whiskey (the last remaining from a purchase made when in touch with civilization) and insisted on my being suitably inaugurated as an honorary member of the mess. He always reminded me strongly of John Silver, though he had his proper complement of legs; a man of great discretion and terrific command of lurid metaphor. The camp consisted of two large tents; the cook's tent, perhaps 12 feet each way, ingeniously fixed to the rear of his wagon, which formed its fourth side and contained a folding table and shelves opening into the tent; and a sleeping tent, rather larger than the other, pitched a few yards off. The cooking apparatus consisted of a good stove with a chimney leading through a hole in the roof of the tent.

There is very little to be said about the sanitary arrangements as, like snakes in Ireland, they do not exist. Two days in one spot would certainly breed the plague; but the cow-puncher usually shifts camp twice a day, and does not think it worth while to stow his empty tins under stones in order to preserve the scenery.

The hours for meals were rather old-fashioned — breakfast at

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5.0 a.m., dinner at 11.0 a.m., and supper at 5.0 p.m. There was little variety in the bill of fare, which on each occasion consisted of fried meat, tinned vegetables, bread, and strong tea without milk; there was generally a fruit pie to be had by looking for it or making love to the cook. The cowboys spend about twelve minutes a day feeding; perhaps they line their insides with the empty tins; mine was not so armoured, and suffered accordingly.

My first experience was to help the day-herd round-up his horses, which had to be corralled previously to striking camp. Western stable management is exceedingly simple: the horses are never watered, fed, or groomed, and rarely shod; and except when it is their turn to be ridden they are practically free agents.

The country is everywhere splendid grass, and, since camp is always pitched near some creek, there is no difficulty about water. In regard to drinking the horses pay more attention to the rules of health than do the men; the former always stray up stream to get unfouled water; the latter go to the nearest place, where the water, by the time they come for it, is the colour of sepia.

Three times a day—after breakfast, after dinner, and when the night-herds go out—the horses are driven into a corral built of sticks and leather thongs, so that the riders can select and rope their mounts. The western horse will not allow himself to be caught without being lassoed. So, while they are closely packed in the corral, each man goes in, ropes his selection, and fetches it out. There is a great fuss among the horses all the time, each struggling for the outside berth, as the man with the rope is in the middle. They rarely kick each other, and as they are unshod 'treads' are harmless; but they go in for a good deal of mild biting. Sometimes it takes three or four men on the rope or while saddling if the horse is a 'bronco'; such an one, too, will be encouraged to play havoc for a time after being girthed up, so that he may only have his second-best efforts reserved for his rider.* After the selections have been made the 'bunch' are let loose again; if they are to march they are driven to the next camp, otherwise they return to their grazing grounds and keep the herdsman pretty busy: now and then one will stray, but his brand will always bring him back in time.

The cowboys' horsemastership would alarm the authors of the Cavalry Drill Book. Immediately a rider comes into camp he removes his saddle and bridle, and suggests to his horse with a kick that he may now join his friends. (The kick, by the way, is a

* There was one, a 14·2 pony, who was a confirmed bolter. His rider gave him his whole fifty feet of rope; off went the pony, down sat the rider with the rope round his back, throwing his weight against it just as the pony reached the end of his tether. The result was always an end-for-end reversal of the pony, who, after trying every direction with the same conclusion, was finally pulled in and mounted.

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recognized instrument of correction). The only time I saw horses watered was just after their feed (not, I admit, grain, which is hardly ever given even at a ranch). Although the horses' manes and tails are profuse, I never saw them touched with a brush.* The only remedy for sore backs, cracked heels, and all wounds is the cook's lard, or perhaps wagon grease; and yet I believe sickness of any kind is most rare. But what anomaly cannot you expect in a country where the saddles weigh more than the vehicles ?†

At first sight an Englishman is inclined to laugh at the Mexican saddle as the *reductio ad absurdum* of weight and clumsiness; but nothing less massive will take the shock of the roped steer. The horn, which appears so excellent a thing to hold on to and so unpleasant in case of a fall, has more uses than its chief one, which is to provide a holdfast for the rope: it is an undoubted advantage in mounting a 'mean' (wicked) horse, and also in holding up a leg when shoeing or casting. Stop at Regina on your way out and get the genial riding master of the North West Mounted Police to show you how he teaches a remount to stand fire lying down (to use an Irishism); he can almost do it while you wait.

The stock saddle possesses many other points unusual to our eyes. Its two cinches (or girths), placed as in a lady's saddle, are built up of several returns of broad leather connected by a short raw-hide girth under the belly: nothing less would successfully resist the infuriated efforts of a bronco. The huge wooden stirrups, for winter work when the thermometer may show 50° of frost, the innumerable little thongs for carrying the rope, the 'slicker' (a huge yellow waterproof), etc., complete the equipment.

The bridle is either a straight bar snaffle or a curb with a very high port—never both. Only one pair of 'lines,' as the reins are called, are ever used; a cow-puncher has no time or inclination to be playing around with his horse's mouth. The reins are unconnected, so that they may drop to the ground when the rider dismounts: the horses never move when they are down. My own bridle had the reins riveted together close above the mane, so that I held one rein only; but so well trained are all cow-horses that this was ample.‡

In striking contrast with the general serviceability of the rest of the saddlery are the wonderful decorations, often of silver, with which a

* An interesting use for the long tail was seen with draught horses (or work-horses, as they are called). An uncertain horse will have his tail plaited and tied to that of his companion.

† The Mexican saddle weighs 30 to 40 lbs. Some racing buggies do not reach 25 lbs.

‡ Why are not English horses more broken to neck pressure? We might in time attain to the bit-less bridle which is sometimes used in America; one pattern, called the 'Hackamore,' applies the pressure by means of a strap on the nostrils.

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cowboy decorates his bridle and reins. He spends money freely this way.

We said above that the equipment of a cowboy is businesslike; the remarks apply equally to his clothes. He rides in an ordinary long-trousered suit, the coat being usually on the wagon. The trousers are, however, close-fitting and covered by a rough pair of overalls. The boots are Wellingtons, with very high heels to prevent the foot slipping through the stirrup; round the boots are buckled a pair of long-shanked Mexican spurs with huge rowels; a turn of the ankle, instead of a kick, suffices to bring them into action. Some of the spurs worn are very ornamental, costing 5 or 6 dollars a pair; a few men possess silver ones. The headgear is a stiff-brimmed 'Stetson' hat; the cowboy does *not* turn up the edge like a South African hero. A heavy pair of gauntlets complete the kit.

It is curious that men who live on horseback, like Boers and cowboys, should prefer long trousers. They are certainly cheaper, easier to fit, and quicker to put on than breeches. Perhaps the British Cavalry—? ? But we forget what their appearance would be on escort duty!

The ordinary working day is something as follows. At 4.0 a.m. the cook rises to light the fire; at 5.0 everyone is up. After a hurried toilet and a breakfast eaten after the manner of the Jewish passover, the horses, which have by this time been corralled by the night-herd, are roped and saddled. The wagons are packed (this takes rather less than ten minutes) and the 'outfit' gets moving. Three quarters of an hour would cover the whole time from 'reveillé' to 'walk march.'

The riders get on ahead, while the wagons, followed by the horses and their herdsman, make for the next camp, perhaps half-a-dozen miles away. Meanwhile the riders have divided up into three or four groups, and proceed to cover a front of perhaps four miles. What scouts these men would make! They know at all times what their neighbour will do and what he will omit; and they will weigh accurately, with the skill of an engineering pocket-book, the disadvantages of a curved route as against those of a steep grade.

The rounding-up of the cattle and the driving them to the rendezvous is preliminary to the lengthy process of separating the owner's cattle from all other brands and of the former bunch into one herd of steers and another of bulls, cows, and calves. Often the boys are picking out the cattle of two or more owners, which adds to the difficulty. The two herds are then driven near camp and guarded, while the men have dinner. It was always a mystery to me how the herdsmen had their meals; I believe they went without.

In the afternoon camp would probably be struck again and the morning performance repeated. Then, after supper, the calves are branded. A good roper brings them up in turn, lassoed by a hind leg

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and bitterly bemoaning their fate, while the cow follows her offspring, lowing an ineffectual protest. A minute suffices for each branding, and the calf trots off bravely, thanking heaven he is still alive. When a well-grown one is brought up a favourite cowboy game is to wrestle and throw it, a feat requiring some dexterity.

Once or twice a yearling steer had to be caught for beef, and once an old cow had to have her horn cut. In such cases two horsemen are required, and the beast is roped, neck and leg. A good cow-horse takes the whole proceeding as a matter of course; he will face the roped steer and throw himself back on his haunches without a visible hint from his rider; he is even trained to hold down the steer while his rider dismounts to tie up the latter's legs.

About half-past eight in the evening the horses are again corralled; the night-herds' horses are then chosen, saddled, and tied to a wagon, and the rest sent out again. Night-herd reliefs are about two hours each, and the rider is kept hard at work. Two men are needed for the cattle. The horses are herded by the same man every night; he is supposed to be off duty by day, but is generally treated as assistant cook, wagon-packer, and harnesser; I do not think he ever sleeps.

Such is the ordinary day, broken only every week or so, when the 'outfit' touches the railway to ship beef, most of which goes alive to Liverpool. On such an occasion the little village, which proudly calls itself a town, has something to talk about. The cowboy and civilization are like two chemical substances, the compounding of which produces strange and noisy results.

The Western horse is astonishingly hardy when it is remembered that he is grass fed. It is probable that his temper arises entirely out of the fierce way he is broken. The cowboy is a very rough rider indeed and a great butcher on a horse; and there is little doubt that it is fear which causes a horse to buck. The men have not time to break carefully and, good riders as they are, do not wish to do so.

A cowboy has his little vanities like the rest of us. One is that he insists on having his spurs and hat on when he is photographed; another that he's jolly well going to have as hard a 'pitching' (buck-jumping) horse in his string as any other man. Great is the joy of the rest when one of them gets into trouble: "Stick him, stick him," they all yell to the unfortunate who, with one line pulled out of his hand and one stirrup lost, is being carried down a hillside on a twisting buck-jumper. Nor must you 'touch leather' (your horn or cantle), or it will be remembered against you.

Well, they can ride; and if they have not got the morals of a guardian angel, they work like men. Keen sportsmen they are too. It is worth going 5,000 miles to see the buck-jumping competition at Calgary fair every July. This year a negro gave even the cowboys a few hints in throwing a steer; galloping alongside it, he would jump on the steer's neck, and throw himself forward until he could grasp

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the muzzle with his teeth; then a vigorous twist of the horns and pull with his teeth would bring the steer down on the top of its conquerer, who, however, always succeeded in falling unhurt.

Rousseau's return to Nature has often results which would have been mourned by that philosopher. Yet all these things which we have tried to describe are very good to see and to take part in. And most of all is this realized when one's ways are again ordered and one's paths prescribed by a critical civilization. It is then that the thoughts sometimes turn regretfully to the careless life, the undefeated resourcefulness, and the ubiquitous hospitality of the West.

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THE EMPLOYMENT OF SURVEY SECTIONS IN WAR.

By Bt. Col. H. M. Jackson, R.E. (*A.A.G. for Topography, South African Field Force, 1900–02*).

1. War Conditions affecting Employment.

In any discussion of the employment of Survey Sections in time of war it is necessary in the first place to summarise the conditions which would affect essentially the nature of such employment.

For this purpose we may divide all possible—not necessarily probable—campaigns under the following headings :—

(*a*). An invasion of the British Isles.

(*b*). A campaign on the continent of Europe as the ally of some European Power.

(*c*). A war in one of our own Colonies ; *e.g.* in South Africa.

(*d*). A war on or beyond the frontiers of India ; *e.g.* in Afghanistan, or in some other more or less uncivilised country (such as Persia) of which no maps exist or of which the existing maps are incomplete or defective : or in the Colony of some other European Power.

(*e*). Minor expeditions against more or less savage foes in countries only partially surveyed or merely roughly reconnoitred or of which no reliable maps at all exist ; *e.g.* the Soudan, Somaliland, and parts of West Africa.

2. Normal Functions of Survey Sections.

Now the *primary duty* of a Survey Section in war is to carry out a rapid "*Topographic Survey*" of the country operated in on a sufficiently large scale and with sufficient accuracy for military purposes ; and, if necessary, to *reproduce the results* for present use in the field. (A more complete designation therefore of this unit would be "Survey and Mapping Section," or—as in this article—the Section may be considered as divided into Survey and Mapping Detachments).

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Other "*secondary*" duties may be summarised as follows :—

(i.). Special reconnaissances.

(ii.). Special surveys of positions chosen for defensive purposes, of important passes, or of other localities which it is thought might be utilised in the course of the operations ; and special surveys for fortified camps for Base Depôts, or other similar purposes.

(iii.). (Mapping Detachment). Reproduction of maps obtained in the country, or captured from the enemy, or in order to augment any original supply of maps which may have run short.

(iv.). (Mapping Detachment). Reproduction of results of special reconnaissances and surveys, carried out by the Survey Detachment or by individual officers or otherwise obtained.

(v.). (Mapping Detachment). The preparation of special maps for issue with orders.

3. EMPLOYMENT OF SURVEY SECTIONS UNDER VARIOUS CONDITIONS.

With the above data for the duties of Survey Sections we may now consider their employment under the various conditions indicated in 1.

In British Isles.

(*a*). In the British Isles the Ordnance Survey maps are so complete and up to date that it is probable that, in the event of an enemy's force having effected a landing, the chief duties of Survey Sections with our forces would be of a "secondary" nature, viz., those detailed as (i.), (ii.), (iv.) and (v.), especially the last mentioned, in para. 2 above.

On Continent of Europe.

(*b*). In any campaign on the continent of Europe (in conjunction probably with another European Power) our troops would presumably be supplied by our Intelligence Division with maps of the theatre of war. Under these circumstances also the duties of Survey Sections would therefore probably be limited to the "secondary" duties detailed in para. 2, subsections (i.) to (v.). It is improbable that a Survey Section would be able to produce any general maps superior to the published maps of the country, unless the scene of operations were, for instance, in parts of Turkey, in which case the duties of a Survey Section would to a certain extent come under the classification of "primary" (*vide* 3 (*d*) and (*e*), pages 276, 278).

In Colonies and Recent experience in S. Africa.

(*c*). In considering the case of the employment of Survey Sections in a war in any of our Colonies, our experience in South Africa has been so recent that it will perhaps be useful to state shortly what was actually done in this respect in that country during the late war.

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At the beginning of the war the maps available for the use of the Army were :—

In Cape Colony.—A general map only (scale about 12 miles to the inch).

In Natal.—An obsolete general map on a small scale and a military reconnaissance survey of the Biggarsberg region, including most of the northern part of the Colony, but unfortunately stopping short at Ladysmith.

In the Orange Free State.—Maps compiled from rough transcripts of the "diagrams" of the Farm Surveys, one series prepared by the Intelligence Division, the other by a private firm in Cape Town, both on the scale of about 4 miles to the inch, both incomplete and unreliable, except perhaps as regards the main through roads, neither in any sense a topographical map.

In the Transvaal.—The southern portion only included in the same two series above mentioned ; also a general map of a superior kind, on the scale of about 7 inches to the mile, compiled and reduced from the original diagrams of the Farm Surveys.

Of all these maps the general maps of the Cape Colony and of the Transvaal were only really of use for General Staff or Administrative purposes. They were, of course, on far too small a scale for tactical purposes, or even for the regulation of the movements of troops with any certainty. This fact in the case of the Transvaal map ("Jeppe's"), which (on account of its convenient size and the excellent way in which it had been got up) was too often used even when more accurate maps on a larger scale had become available, became only too obvious on several occasions. The only good military map—as far as it went—was that of Northern Natal ; and that unfortunately did not go far enough. The other maps above mentioned were to a limited extent useful for the general regulation of the movements of troops, but were not adapted for elaborating any details or for tactical purposes. They were, moreover, in many parts incomplete and inaccurate, even in the distances between well-known places.

Besides "Maps" proper, there were prepared and issued under the direction of the Intelligence Division a number of "Road Reports" and "Route Sketches" of various kinds.

Such then were the cartographic data with which the last South African War was commenced.

The arrangements during the course of the war for improving and adding to these were as follows :—

(1). With the first force sent to Natal was half a "Mapping Section," consisting of 1 officer and 2 or 3 N.C.O.s (R.E.).

(2). In October, 1899, another half "Mapping Section" was sent out to Cape Town, consisting of 1 officer, 1 N.C.O., and 1 sapper (R.E.).

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These detachments were intended chiefly for the reproduction of maps, sketches, etc., in the field, but were provided with means for rough surveys and reconnaissances.

(3). Early in 1900 a "Survey Section" (No. 1), consisting of 1 officer and 8 N.C.O.s and men (R.E.), was sent out.

(4). In May, 1900, another "Survey Section" (No. 2) of the same strength and composition was despatched.

(5). Almost at the end of the war 2 more "Survey Sections" (Nos. 3 and 4) were sent out; but these only arrived in time to complete the surveys of battle-fields for historical purposes.

The strength of the Topographic and Mapping Branch of the Field Intelligence Department for the War period of 1900–02 may therefore be taken as 2 "Survey Sections" and 1 "Mapping Section," consisting in all of 3 officers and from 20 to 30 N.C.O.s and men, including extra R.E. and civilians employed from time to time in compiling, drafting, and printing.

The total area surveyed and mapped (on the scales of $\frac{1}{2}$, 1, and 2 inches to the mile, chiefly on the $\frac{1}{2}$-inch scale) was 13,730 square miles. Of this total, part was published and issued in 12 original maps, the remainder was incorporated in maps compiled from the Farm Surveys of the Colonies. Of these compiled and partly revised maps 116 different sheets were issued—viz., 62 for the Transvaal and part of Natal, 21 for the O.R.C., and 33 for the Cape Colony. Besides these, 3 general maps on smaller scales of parts of Northern Natal and Zululand and of the Transvaal and O.R.C. were compiled, printed, and issued.

In all 463,600 maps of all kinds were printed by the "Mapping Section," of which 307,980 were issued.

"Miscellaneous" work included:—Reconnaissances of the enemy's positions at Paardeberg and Poplar Grove; special surveys of and round Bloemfontein and Pretoria; and the compilation and printing of several thousands of reconnaissance sketches, reports, etc., etc.

It will be seen from the above statement that the Survey and Mapping Sections employed during the late war in South Africa did actually carry out to a certain extent—perhaps as far as circumstances admitted—all the various kinds of duties detailed in 2 as appertaining to such detachments. But it is evident that their strength and organisation were quite inadequate to carrying out these duties to their full extent; for the area of the military operations from first to last may be put roughly at about 300,000 square miles. Indeed, had it not been for the material found available at the several Colonial survey offices, it is improbable that the original map supply could have been improved except for comparatively small areas here

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and there over the immense tracts of country traversed by our columns.

Unfortunately the material derived from the Farm Surveys was of very unequal value. In the older Farm Surveys, more especially of the Cape Colony and Orange Free State, it was practically valueless from a topographical point of view. But most of the Transvaal Farm Surveys, being more recent and better in every respect, afforded very fair material; so that some of the maps of this part of the theatre of war, when revised by means of actual survey, and by sketches and information supplied by staff and regimental officers in the field, became quite useful for military purposes. However, maps so prepared, not based on any systematic topographical survey, must always include much information of unequal or doubtful value, even if not positively misleading. The best that can be said of them is that they were issued *faute de mieux*, and that the utmost was done with the means at disposal to improve them.

It must be remembered, however, that the systematic preparation and issue of these maps did not begin until *after* the main Boer Army had been defeated and dispersed near Belfast, though for that action and for the action known as the Battle of Diamond Hill maps in the form of "sun-prints" had been issued. Of these, the latter, owing to hurried preparation, was by no means so good as it might have been. From November, 1900, the preparation and issue of maps was systematised and proceeded regularly.

It is to be hoped, however, that in the event of another war—of whatever kind—in South Africa, it may not *then* be necessary to make use of the experiences here related, but that *before then a proper topographic survey of these Colonies will have been carried out.*

In fact, the best employment of Survey Sections in our Colonies *is in time of peace*—in the carrying out of deliberate surveys, which may be useful not only for future military purposes but also for the immediate purposes of civil administration and for the development of the Colonies in all directions in which such surveys are necessary. The employment *then* of these units in the same countries *in time of war* would be limited to the special or "secondary" services detailed in subsections (i.) to (v.) of 2.

On Frontiers of India.

(*d*). The subject of the employment of Survey Sections on the frontiers of India is fully dealt with in the *Handbook of Professional Instructions for the Topographical Branch of the Survey of India* (Chapter on "Frontier Reconnaissance"). Moreover, any further information or discussion on this subject should certainly be supplied by one of our officers who has been chiefly employed on such work on the North West Frontier. My own experience on the Eastern Frontier, though with troops, has been more in geographical than in topographical work, and was mostly individual or in company with

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only one assistant. Any original data I could supply would relate chiefly to minor details of equipment, etc., which will appear in their proper place.

The work of the Survey Sections or "Parties," supplied by the Survey of India for employment with columns operating against the hill tribes of the Northern and North-Western Frontiers, has been of a very important nature, and has proved extremely useful in subsequent military expeditions and in the general administration of the Frontier. The duty of these detachments has been generally to map as much as possible of the country traversed by the columns. From the skill, energy, and adventurous spirit of the experienced topographers employed on these expeditions, the favourable nature of the country and the fact that importance is wisely accredited to such work in India, has resulted the mapping of the greater part of the frontier regions which, until quite recently, could not be entered in a peaceful way for survey purposes. In a hilly country free from forest or bush, skilled topographers, if provided with proper escort, or if accompanying the flanking columns of the general advance, can even map a certain amount of country in front of the main column under favourable circumstances and in clear weather. The instant utility of such work is inestimable. A compilation of the survey reports of these Trans-Frontier Expeditions would be of great interest, and would supply invaluable material for a discussion on the subject of this article.

In the event of a regular campaign, entailing the employment of considerable bodies of troops *beyond* the Indian Frontiers in countries as yet unsurveyed though perhaps partly reconnoitred from time to time by individuals, a more complete field service Survey organisation would be necessary than has been required for ordinary Trans-Frontier Expeditions. However, India has always the advantage of possessing a number of trained officers and men who could, if required, be employed on such work. The excellent work done by a "Survey Party" in China during the recent Pekin Expedition affords a case in point. If the trained personnel is immediately available, it is only a question of proper equipment and judicious employment, with due protection when necessary. Given such a personnel, the control of several sections would offer no difficulties.

The employment of Survey Sections in a campaign in such countries as Persia or China, in company with a large force, would probably be subject to the same conditions as in the case last discussed. But it is probable that in a Persian campaign, for instance, we should have to depend partly on personnel supplied from England; and this, if present conditions still prevail, not being so well trained or so experienced as the personnel available in India, would demand a more elaborate organisation and a closer control.

From my own experience in the recent war in South Africa I am certain

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that, for the army in the field to derive all possible advantage from these technical detachments, it is necessary that there should be in general charge of them a technically qualified and experienced officer on the Staff of the General Officer Commanding, *i.e.*, a "Staff Officer for Topography."*

But the chief lesson to be learnt from the South African War is that, in the course of an advance through an unmapped or inadequately mapped country, whether actively hostile or not, all available trained men should as soon as possible be put on to the "Survey" or "Reconnaissance" of as much of the country traversed by the columns as they can see. Even if little work can be carried out *in front* of the advance, one can never be certain that a knowledge of the country on either side or already passed over will not be just as important for military purposes a few days afterwards.

If the country is actively hostile as a whole, *i.e.*, if apparent non-combatants would attack isolated individuals or small detachments, the number of surveyors employed must be conditioned by the number of troops available for escorts. In the late South African War regular escorts were never available for survey or reconnaissance purposes; officers in charge of Survey Sections had therefore to make their own arrangements. The conditions in this war were, however, in this respect quite exceptional, owing to the extraordinary mobility of the enemy and the boldly independent action over immense tracts of country of numerous small "commandos," especially in the latter phase of the war, from the end of 1900 to the termination of hostilities. So that, even if an attempt had been made during that time to carry out extensive surveys by means of numerous protected sections, the probability is that such small isolated detachments would have fallen victims to the enterprising enemy. This indeed was actually the fate of one unprotected and unsuspecting survey section during the late war.

In the first phase of the war, however, if a number of trained and experienced Survey Sections had been available for work in the Cape Colony and in parts of the Orange Free State, when the Boer forces were rolled back by our advance and by the relief of the beleaguered garrisons, and if it had been possible then to predict the future course of the war, it is probable that much work could have been done which would have proved of inestimable value during the operations of 1901–02. But it is easy to be wise after the event. *It remains to us to profit by the experience.*

In Savage Warfare.

(*e*). The employment of Survey Sections with minor armed "expeditions" into hostile countries is best typified by our experiences on the Indian Frontiers, which have been referred to in the preceding paragraphs. There remains therefore little to add under this heading.

* See under 4 below.

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Moreover, what may reasonably be expected of surveyors on such expeditions must always depend largely on the nature of the country, on the climate, on the disposition of the inhabitants generally, and on the strength and character of the combatant portion of them. On small expeditions – consisting of only one or, perhaps, two small columns—in forest or bush-clad country, or in country in which the operations are limited by conditions of water supply or by other local considerations to a single line of advance, it would only be possible to employ two or three men ; and these could perhaps do no more than survey and map a very short distance to either side of the route.

It must be remembered, however, that such small expeditions, generally undertaken for a punitive object with no immediate intention of occupation, are necessarily only temporary in their effect and have often to be repeated. Thus the geographical or topographical information acquired on any one such expedition—however meagre it may appear, and though it may have been of no use at all on that particular expedition—may prove of great use on a subsequent one into the same country. In the selection of individuals or detachments for such work, the chief essentials are experience, quickness, energy, and activity. An equipment exactly adapted to the country and to the conditions under which the work must be carried on is also a very necessary consideration.

4. ORGANISATION.

Having discussed the various circumstances under which Survey Sections may be employed in war, it remains to consider the organisation (and subsequently the best equipment) necessary to render such employment effective.

With due regard to the purposes for which Survey Sections may be employed, the normal effective "unit," *i.e.* the maximum number of surveyors that can as a rule be effectively controlled by one officer for independent work, appears from experience to be from 6 to 10. But since in the ordinary course of war it is usually impossible to replace without considerable delay a technically trained officer, it seems very desirable to provide for two officers with each Section ; and there is moreover the mapping detachment to consider. A normal Survey Section may therefore be defined as 2 officers, 8 surveyors and 3 lithographers, with the necessary drivers and batmen according to circumstances. For *authorised* normal Establishment see Appendix.

When there are more than 2 Sections the Staff Officer for Topography* might be provided with an assistant, to be employed in inspecting the work of the Sections, in ascertaining their requirements, in arranging details for their supply and transport, and in issuing the maps. As a rule it would be advisable for the Staff Officer at Headquarters to keep with him the "*mapping* detachments" of the Survey

* See under 3 above.

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Sections, and to superintend personally the compilation and reproduction of maps and their issue to the troops. Thus the staff of the Topographic Branch of the Field Intelligence Department should consist of officers who are well versed not only in survey methods and procedure but also in all the technical details of the reproduction of maps.

In the case of minor expeditions as in 1 (*e*), or in such special cases as are indicated in 1 (*a*) and 1 (*b*), the unit section would of course be modified to suit the conditions and requirements of the case. In some cases only one or two special officers or N.C.O.s would be selected for the work.

5. EQUIPMENT, ETC.

The equipment of Survey Sections, or of Survey detachments, or of individuals detailed to expeditions for survey purposes, must depend on the nature of the country operated in and the nature of the operations.

The details of equipment and transport of a normal section having now been prepared and authorised, it is easy to modify them for adaptation to each special case.

The authorised Lists are given in the Appendix, with a few additional suggestions.

6. TRAINING OF SURVEY SECTIONS.

In order that Survey Sections or Detachments may fully justify their employment in time of war, it is obviously essential for the personnel of which they are composed to be thoroughly trained in time of peace in carrying out rapidly and with sufficient accuracy the kind of work which will be required of them on active service. For this purpose their training should be under war conditions. It is evident that there is a great difference between carrying out a survey deliberately and carrying it out within certain limits of time and under conditions which may preclude the whole of the area under survey being actually visited.

In India we may generally count on the Survey of India Department being able to supply a sufficient number of trained topographers used to working under practically service conditions; but even in India this supply will be gradually diminished as the surveys of the Frontiers are completed and the topographical surveys generally become reduced to revision or re-surveys on larger scales.

In the Colonies, however, we have no such supply to draw upon; and in the British Isles we have only a relatively small number of men, available at any one time, trained in the Ordnance Survey and at Chatham. The Survey Sections sent out to the recent South African War were all drawn from the Ordnance Survey, and most of

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the men were not trained for the special work required of them until after the commencement of the war.

That these men did so well says much for the administration of the Ordnance Survey and the officers who carried out the training, as well as for the natural ability of the men themselves. This training in the Ordnance Survey Department has now been considerably extended and regularly systematised; so that we may in future hope to have a fair supply of military topographers whenever their services are required.

I would strongly recommend, however, some instruction in riding and horse management—*not in "equitation."* It should be possible to attach the men to mounted infantry units for short periods with this object.

Some arrangement should also be made by which N.C.O.s and men transferred from the Ordnance Survey to Survey Sections on active service should not lose pay, as was often the case during the South African War. However efficient a man may be technically, it is not probable that one will get the best out of him, if he thinks he is being unfairly treated as regards pay, etc. Besides he often leaves a wife and children at home dependent on his pay for the necessaries of life.

There is yet another point to consider with reference to the training of military topographers, viz., whether the ground available is suitable for this purpose, *i.e.*, whether probable war conditions can be fairly attained.

In a country like the British Isles, in which most of the land is enclosed and the wilder parts generally preserved for game, it is difficult to find large areas suitable for training. In the Colonies, however, more particularly in Canada and South Africa, there are immense areas practically unsurveyed topographically, which could be used for the training of an unlimited number of men. One of the many advantages to the Empire of the proposed Topographic Survey of South Africa was that it would have afforded such a training school. Now that, in default of the promised co-operation of the South African Colonies, this particular scheme must apparently be postponed, it can only be hoped that some other means may be found of attaining the desired end independently of the varying conditions imposed by the circumstances of Colonial Governments.

7. NECESSITY FOR ENLARGING THE SCOPE OF THE TOPOGRAPHICAL SECTION OF THE WAR OFFICE.

The want of proper maps during the late South African War, the still incomplete and unsatisfactory state of the maps of the South African Colonies and of those of the greater part of other Colonies, and the fate—as it appears at the present time—of the proposed

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Topographic Survey of South Africa, all point to the conclusion that what is required is to extend the scope of the "Topographical Section" of the War Office, so as to assimilate this "Section," as far as the general conditions of our army admit, to the Military Topographical Departments of the Continental Powers.

8. SURVEY METHODS.

It is not proposed in this article to enter into any details of the technical work of Survey Sections. But a short discussion of this subject in general terms may perhaps be useful.

The main principle on which all survey work, however rough or hurried, should be carried on is that it should be based, whenever possible, on some kind of triangulation, even though this may be very far from rigorous. Unless this is done the true value of any detail work can never be even approximately estimated, nor can separate surveys or reconnaissances of any kind be connected with any certainty of accuracy. Moreover, any time spent on triangulation is saved many times over in the increased rapidity and completeness with which detail work can be carried on between points previously determined; and, generally, it may be said that the greater the number of fixed points given to the detail surveyor the more accurate—*ceteris paribus*—will be the resulting map.

The main principles of precise surveying hold good in fact for even a rough reconnaissance; and it is the intelligent adaptation of methods to the required result that is the chief criterion of the value of that result and of the capacity of the topographer. It is in this connection that the actual experience of work under difficulties is so necessary. Without such experience the military topographer, when he is first started under service conditions, will usually find himself hopelessly at sea; and the opportunity for the immediate usefulness of his work may have passed away before he has found out how to adapt himself to circumstances.

REPRESENTATION OF GROUND.

It is in the quick mental grasp, and in the intelligent representation in a rapid way, of the characteristic shape of natural features and of the relative steepness of slopes that considerable experience and training is most necessary; the more so because the education of the eye to see correctly—which, after all, is the main thing—is not facilitated by the general conditions of modern civilisation.

In this connection I have noticed, with regard to both officers and men trained in England, that there is a tendency to regard the "form-lines," with which they have been taught to represent ground, too much as if these were rigorous contours to be carried through the map as such without regard as to whether they serve to convey a correct impression of the ground or not. So much is this the case that—for

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instance—I have seen maps made on this principle which I have quite failed to recognise as representations of ground that I knew intimately. The military topographer should be taught to use this means for the representation of ground in a more intelligent and elastic way.

In military surveys there is seldom time for systematic contouring, nor will the purpose of the work usually (*i.e.* except in special cases) justify the expense. The essential is to preserve a sufficient control of the "form-lines" by means of numerous observations of relative heights—by clinometer or aneroid--and to record on the final map a sufficient number of these heights to answer all probable requirements.

In this respect greater attention should be given to the systematic and intelligent use of the aneroid barometer.

TACHYMETRY.

There is one other question in connection with survey methods which I think may be usefully mentioned here, viz., the rapid measurement of distances when the topographer has no fixed points within view.

It is true that in very rough work distances may be timed or paced with good results, provided there are connection or closing points of some kind at intervals; but, for any sort of work that may be called "Survey," such methods are not good enough, except for very minor detail at very short distances between known points. What is required is some means of distance measurement in cases in which direct measurement—*i.e.* by chain, band, rope, or "perambulator"—cannot be carried out and where positions cannot be interpolated from known points.

"Tacheometric," "subtense," or "stadia" methods of measurement have been little used in England or in India compared to the extent to which they are utilised on the continent of Europe and in the United States of America. It appears advisable that military topographers should be trained to some such methods of measurement; and that some light form of telescopic alidade, fitted with stadia wires, and a light telescopic stadia rod should form part of the equipment of each plane-tabler, not necessarily to be always taken by him into the field, but to be at hand for use when necessary. With the same object the theodolites used for the triangulation should also be provided with stadia wires or lines. For mounted work on emergency it will be well also to supply the Sections with one or two good range-finders of the pattern found to give the best results.

REPRODUCTION OF MAPS IN THE FIELD.

It is obviously essential that Survey Sections should be provided with means for the reproduction of their field sheets for immediate use. Hand lithographic (or zincographic) presses have lately been

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made and approved, which, in one or other of the three patterns prepared, are adapted for any sort of service or mode of transport. With these the field work would be got on to the stone or plate for reproduction by "tracing-transfer" *under ordinary circumstances*. Circumstances may often arise, however, in which it may be essential to be provided with some more rapid means of reproduction than this; for tracing of anything like close or intricate country may take a long time. It appears therefore advisable that some photographic process apparatus should be provided, even though generally it might have to be utilised at the Base of operations. The "Vandyke Process" is one of the most suitable, and provided a fair water supply were available in the country to be traversed, the apparatus for this process might accompany the Section. In any case the best form of "Sun-printing" apparatus and materials should be supplied for use at the front.

It must be remembered, however, that, in order to make use of photographic methods of any kind, the field sheets must be penned in with this end in view, or tracings on tracing cloth of the field sheets must be kept up suitable for photographic reproduction. The tracings would of course, if kept entirely in opaque black and red, be suitable for any process—including "Sun-printing"; and, if the surveyor gets into the habit of tracing as much as he has quite finished every two or three days, or even every week, this extra work soon ceases to appear unduly irksome. In a hostile country moreover it is often necessary, in order to minimise as much as possible the chance of large quantities of work being entirely lost, to keep tracings in camp of the work which is taken out into the field.

In default of tracings the field sheets themselves should be penned in so that fair photographic negatives may be obtained from them by means of an ordinary Photo-Process Camera. There would be no difficulty in adapting the apparatus required for this method to any sort of transport.

I have also touched on this question of photographic reproduction in my remarks on the authorised Equipment for Survey Sections.

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APPENDIX.

DETAILS OF PERSONNEL, TRANSPORT, AND EQUIPMENT OF SURVEY SECTIONS.

Note.—Since this article was written, in S. Africa in June, 1905, I have had access to the lists of authorised establishment and equipment of Survey Sections and have obtained permission to publish them. I therefore insert here these authorised lists in place of those I had prepared independently; but I have also attached to each such suggestions or recommendations as I think may tend to the further efficiency of the units in question. Those who have had any experience in the production of maps on active service, or under difficult conditions in wild and sparsely inhabited countries, will know that no apology is necessary for the discussion of details which, to the ordinary reader, may appear trivial and insignificant.

PERSONNEL.

(*Authorised Establishment*).

2 Officers (1 Captain and 1 Subaltern).
8 Surveyors (N.C.O.s, including 1 Sergeant, and Sappers).
3 Lithographers.
1 Shoeing and Carriage Smith.
2 Drivers (R.E.).
1 ,, (A.S.C.—2nd Line Transport).
4 Batmen.

Total 21

TRANSPORT.

5 Riding Horses.
5 Draught ,,
3 Carts (of which 1—a light, spring cart—to be provided locally).

Remarks on Authorised Establishment

Drivers.—It would probably be found more economical to substitute native for R.E. or A.S.C. drivers in Africa or Asia.

Riding Horses.—I am strongly of opinion that in any but very hilly country all surveyors should be mounted or provided with light carts. The officers should of course be mounted. I found in S. Africa that to obtain any fair out-turn of work it was always necessary to mount my men; and eventually they nearly all learned to work with ponies.

Draught Horses and Carts.—Provision should be made in case of pack transport being necessary. For this purpose pack saddles should be authorised as alternative articles of equipment; and the "Bullock Trunks" specified should be such as may be used as "Mule-Trunks,"—with rings and straps for attachment to saddles. All necessary survey and mapping instruments and stores can be carried on pack animals.

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INSTRUMENTS AND STORES.

(*Authorised List for a Survey Section*).

	Alidades, telescopic	2
	Bags, canvas	12
	„ letter, leather	2
	Balances, spring, 30 lbs.	1
	Bars, subtense	2
	Bottles, ink, fountain } „ „ surveying }	16
	Bullock Trunks	6
	Cases — Carrying Instruments, padded leather, with Straps	3
	Cases — Sketching with Straps, 17″ × 15″	4
	Cases — Tin and iron, for Plans, etc.	10
	Cavalry Sketching Boards	2
	Chains, measuring, 100 feet, with 10 Arrows, Sets	2
	„ „ Arrows extra, Sets of 10	2
	Chairs, Camp	2
	Covers, Instrument, waterproof	3
	Curves, French, Sets	1
	Erasers, with sheath	12
	Flags, Station	24
	Hones, Oil	1
Instruments	Aneroids, 2½″, graduated according to circumstances	10
	„ 5″ „ „ „	2
	Binoculars in sling Cases, Zeiss Pattern	8
	„ „ Extra Power Zeiss	2
	Clinometers, "Tangent," Indian Pattern	8
	„ „ „ „ Cases and Slings for	8
	Compasses, Beam, 3 feet, graduated Inches and Decimals	1
	„ „ 2 „ „	1
	„ Bowsweep, Pen	10
	„ „ Pencil	10
	„ Prismatic, Hand, luminous	8
	„ „ „ Cases, leather with Slings	8
	Compasses, Prismatic, 4½″, with Tripod	2
	„ „ „ Cases, leather Sling with Straps for	2
	Compasses, Proportional	2
	Heliographs, 5″ Mark III. in leather Case, with Stand, complete	2
	Heliostats	3
	„ Cases and Straps for	3
	Holdalls, Leather, fitted with Compass with shifting Leg, Pen Point, Pencil Point, lengthening Arm, Pen Bowsweep, Pencil Bowsweep, Pens Drawing single (2), 6″ Ivory Protractor, 6″ Ivory Parallel Rulers, Knife and Turnscrew combined	10
	Levels, Pocket (Abney's)	8
	„ „ Cases, leather Sling with Straps for	8
	Pantagraph	1
	Perambulators	1

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Instruments	Protractors	Brass, 12″ Circular	2
		Celluloid, 12″ ditto	3
		Ebonite, 6″ ditto	2
		Ivory, 6″ Rectangular	6
	Rulers, parallel, 18″		1
	„ „ 6″ Ebonite		4
	Scales	Ivory or boxwood, 1″ to 1 mile	12
		„ „ 2″ „	4
		„ „ 6″ „	4
		„ „ 1″ to 10 miles	2
		„ „ 1″ to 2 miles	12
		Gunter's, brass, 2 ft. divided into Inches and Decimals	1
	Instruments, drawing, Box, superior, with Instruments complete		2
	Tables, Plane, R.E., 18″ x 24″, complete with canvas cloth Covers, Tripods, magnetic Trough Compasses in leather sling Cases with Straps, and Sight Rules in leather Cases with Straps		9
	Tables, Plane, 18″ x 18″, Portable (with accessories as above)		4
	„ „ „ spare Screws for		12
	Tapes, measuring, 100 ft.		12
	„ „ steel in "Boxes"		4
	„ Boxes for 100 feet Tapes		6
	„ Steel, 300 feet		1
	Telescopes, "Deer-Stalking" Pattern		1
	Theodolites, transit, 5-inch		2
	„ „ 3″ or 4″		1
	„ „ Telescope for, with extra power, for 5″ Theodolite		1
	Thermometers, swing, in brass Tubes		8
	Watches, Keyless, "½ Chronometer"		3
Knives, Pen, pocket			12
Lamp, Reading, in Box			1
Lanterns, Bicycle			4
„ Camp			2
Needles, Sailmakers'			12
Palms, „			1
Poles, Traverse, Supports for, and Fittings for plumbing			6
Planispheres, "Phillips," 1 North and 1 South			2
Spirits, methylated ... ... Gallons			2
Stones, Oil, Carpenters', 8″ long in wooden Frame			1
Straight-edges, steel, 3 feet			1
Tools	Axes, hand		2
	„ felling		1
	„ Pick		2
	„ Pick, Helves for		2
	Billhooks, longhandled		1
	„ shorthandled		1
	Awls, Brad, Carpenters'		6
	„ Handles for		6
	Hammers, piling		1
	Roll of, to contain Cold Chisel, Firmer Chisel, 6 Files, 3 Gimlets, Claw Hammer, Pair of Pincers, Handsaw, etc.		1
	Spades		2
	Tools for repairing Saddlery ... ... Sets		1
Umbrellas, Gig			8
Weights, Leaden, for Papers			8

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Stationery, etc. :—

Books	Almanacks, nautical	2
	„ „ for following year	2
	„ Whitaker's	1
	Angle	7
	Observation	12
	Astronomical forms S.M.E. and Notes	7
	Hints to Travellers	1
	Logarithm Tables, Chambers', Shortrede's or Babbage's	2
	Memorandum	12
	Road	30
	Text Book of Military Topography, Parts I. and II. of each	10
Chalks, Coloured.	Blue ... Boxes	1
„	Green ... „	1
„	Red ... „	1
„	Yellow ... „	1
Colours	Boxes of, to contain Lake, Yellow Ochre, Gamboge, Burnt Sienna, Prussian Blue, Indian Ink (in Sticks), and Brushes, complete	10
	Burnt Sienna ... Cakes	12
	Crimson Lake ... „	12
	Gamboge ... „	12
	Indian Ink, 3" Sticks	24
	Indian Ink ... Bottles	12
	Prussian Blue ... Cakes	12
	Yellow Ochre ... „	12
Envelopes	No. 1 white	100
	No. 2 medium white	100
	No. 3 small	100
Gall, Ox ... Pots		1
Gum Arabic ... lbs.		½
India rubber ... Pieces		24
Ink	Powders, black	3
	„ red	1
	Black ... Pints	2
	Red ... „	2
Line, log ... Hanks		2
Maps, Celestial ... Sets		1
Paper	Bank post ... quires	3
	Blotting ... „	2
	Drawing, D.E. "handmade," 170 lbs. ... „	1½
	Foolscap, blue crossbar ... „	10
	„ plain ... „	2
	Note, white ... „	3
	Tracing, D.E. ... „	2
	„ Linen ... yards	96
Pencils	H.B.	24
	H.H.	24
	H.H.H.H.	24
	H.H.H.H.H.H.	24
	Hair, Camel	8
	„ Sable, assorted sizes	24

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Pens, Steel	Holders		12
	Mapping, No. 659	Cards	6
	Mitchell's J	Boxes	2
	Ordnance	,,	2
Pins, Artists'		Doz.	12
Saucers, ink		Sets	8
Skins, chamois			2
Twine	Medium	Balls	3
	Thick	,,	4
	Thin	,,	2

Remarks on Authorised List of Stores for Survey Sections.

Alidades, telescopic.—Should be provided with stadia lines or wires and small vertical arcs (half circle), and the whole packed in flat cases of stiffened leather with slings. Small levels should also be provided.

Compasses, bowsweep, pen and pencil, 10 of each.—These seem unnecessary as these instruments are supplied in the holdalls and boxes.

Compasses, proportional—6.—I would recommend one of these for each surveyor and 2 for office. They need not be "divided." Cases should be supplied.

Holdalls.—It would be convenient to have places for pencils, brushes and drawing pens in these holdalls.

Levels (Abney's).—Improved pattern recommended—with slow motion screw and telescope.

Rulers, parallel.—There should be one large one, 18" or 12", of the rolling pattern. This may be intended, but it is not so specified.

Scales.—Stiff leather cases to hold 2 scales each should be provided—say 10 cases.

Magnetic trough-compasses (for Plane-Tables).—Should be those in wooden boxes with slide lids, length 6". The leather sling case is also sometimes useful. But the metal box trough compasses with outside clamp should be altogether condemned.

Sight-Rules.—Those for 18" × 24" plane-tables should have small cross levels let into the middle of the upper surface. Those for 18" × 18" plane-tables might have small circular levels similarly inserted. One edge of each sight-rule should be divided to a feet scale for 1 inch = 1 mile; the other to a yard scale for ½ inch = 1 mile. I am aware that it is not usual to insert levels on sight-rules; but I have found that inexperienced plane-tablers consider them of great assistance. It must be remembered also that in the kind of work often necessarily undertaken by Survey Sections the plane-table has frequently to be used for extension for considerable distances without any aid from the theodolite; so that every small gain in accuracy is important,

Tables, plane, 18" × 18"—4.—I would recommend this number being at least doubled. They are extremely handy for rapid work, especially if the surveyor is mounted. The saddle attachment should be specified and provided. For the larger plane-tables I would recommend carbine buckets being provided and also arm-slings in order to facilitate their carriage by mounted surveyors.

All plane-table covers should be of "Willesden Canvas" with leather corners, and *sewn by a saddler* or sailmaker not by a tailor.

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Spare Screws.—Should be provided for all plane-tables, not only for the smaller kind—as specified.

Theodolites.—I would recommend stadia wires to be provided for all theodolites and also extra levels attached to the *telescopes*; so that the instruments may be used for levelling, if required. Micrometer-microscopes should be provided on only one if indeed on either of the 5″ theodolites. Such niceties are not adapted for active service. On service the essentials are—powerful telescopes, strength, simplicity and portability.

Tapes, Steel—300 *ft.*—Specify $\frac{1}{8}$″ toughened steel. I would recommend at least 2 of these to be supplied and preferably even more.

Lanterns, camp—2.—I would suggest that *at least* 6 of these should be provided. Allowance must be made for the surveyors being scattered and camped in pairs for considerable periods. It is very important to provide an effective light at night, so that penning in and tracing may be carried on then and preparations made for the next morning.

Umbrellas, "gig."—The specification should surely be "Survey" or "Sketching." A "gig" umbrella is much too heavy.

Weights, leaden—for papers.—Unnecessary luxuries.

Books.—I would suggest—Angle Books 12, Astronomical Observation Books 6, Logarithm Tables—at least 1 each of Shortrede's, Chambers' and Bottomley's, also 1 or 2 copies of the S.M.E. "Reconnaissance Tables." All books should be bound in plain leather, and Almanacs, Forms, Note or Memorandum Books, etc., in strong canvas.

Chalks.—Should be Chalk Pencils—"Creta Laevis" is the best, as supplied by Artists' Colourmen—not Stationery Department.

Colours.—If colours must be used for field-sheets, then Higgin's indelible inks should be used. These stand rain quite well, whereas ordinary water-colours do not. Those colours should be selected which will photograph best—in case a rapid copy of the field-sheet is urgently required. Vermilion, Chrome Yellow, *Prussian Blue* used fairly thick intercept or absorb a good deal of light. Experiments should be made with various greens. "Emerald Green" will probably be the best.

I am strongly of opinion that it is most important that the field-sheet should be penned in in such a way that it may be suitable for photographic reproduction on emergency. To this end the best method is of course to pen in entirely in black, as is done always on the Survey of India. I do not see any objection to this—except that more skill and care is required on the part of the surveyor. If this suggestion is not approved, then the colours should be chosen as above suggested; but, even so, good results cannot be expected when rapid reproduction is required.

The "cakes" of water-colours specified are at all events unsuitable for the field. Gamboge and Prussian Blue soon break up. Pans should be used. Also, I would suggest a made-up green, *e.g.*, "Hooker's No. 2," for the sake of uniformity, instead of Yellow Ochre, and for reasons above stated Vermilion instead of Crimson Lake and Chrome No. 2 instead of Gamboge.

Paper, drawing.—The allowance seems rather small—1½ quires.

I would recommend the "Not" surface for field work, as it stands handling, rubbing and weather better than the "hot pressed" surface.

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Pens—mapping—Cards.—6 only. These are the pens most men prefer for field work. At least 2 dozen cards should be provided. I refer to the small barrel-shaped "steel crow quills" usually supplied on cards.

Other minor articles I would suggest as essential are:—glue and glue-pot, muslin for mounting plane-tables, starch or flour for paste, paste brushes, and brown paper—large sheets.

I would also recommend the following articles of equipment not specified in the above list, viz.:—

Range Finders.—2 at least—pattern most suitable and giving best results to be selected.

Drawing Boards.—2 ft. x 3 ft., with cross battens on underside and folding trestle legs to form tables when necessary.

Tents.—As before stated allowance must be made for surveyors being detached singly or in pairs. I think a "tente d'abris" at least should be provided for each surveyor and perhaps for each batman. Tents are, I see, provided for the Mapping Detachment. Officers should also be provided with small tents. It is impossible to compute, prepare plane-tables, compare edges, etc., in the open, except under extraordinarily favourable circumstances. The smith and drivers could sleep in or under the carts, and probably the batmen also,—generally; as, presumably tarpaulins or cart-covers are provided.

All tents should have jointed bamboo poles; so that they may be easily carried on pack animals.

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MAPPING EQUIPMENT AND STORES.

(Authorised List for a Survey Section).

FIELD LITHO EQUIPMENT "No. 1" (FOR CART TRANSPORT).

Details of Boxes.

No. of Box.	Detail of Stores.	Quantity.	Weight of Stores.		Total Weight of Stores.		Weight of Chests.		Total Weight.	
			lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
1	Litho press, No. 1, complete	1	305	—	305	—	96	8	401	8
2	Stones, litho, double-faced :— $23\frac{1}{2}'' \times 18\frac{1}{2}'' \times 2\frac{1}{4}''$	2	160	—	160	—	66	—	226	
3	Do. do. do.	2	160	—	160	—	66	—	226	
4	Calico, white, dressed	50 yds.	15	4						
	Paper, blotting	5 qrs.	6	8						
	,, white, demy	4 rms.	104	—						
	,, litho transfer, tracing, demy	$2\frac{1}{2}$ qrs.	—	$11\frac{1}{2}$						
	,, chalk, red. demy	1 qr.	1							
	,, litho transfer, writing, demy	$2\frac{1}{2}$ qrs.	4	0						
	,, tracing, demy	$2\frac{1}{2}$ qrs.	1	8	132	$15\frac{1}{2}$	48	—	180	$15\frac{1}{2}$
5	Acid, citric	—	1	—						
	Basins, evaporating	2	—	$9\frac{3}{4}$						
	Brushes, camel hair, No. 5 size	4	—	1						
	,, sable ,, No. 1 ,,	4	—	—						
	Cans, oil, lubricating, G.S.	1	—	6						
	Cotton waste, white	2 lbs.	2	—						
	Drivers, screw, general service, 9"	1	—	$12\frac{1}{2}$						
	Glass paper, No. $2\frac{1}{2}$	12 shts.	1	6						
	Gum Arabic	2 lbs.	2	—						
	Flour	4 ,,	4	—						
	Handles for rollers, lithographic, 11"	1 pair	—	1						
	India rubber	2 pieces	—	1						
	Ink, litho print, black, 1-lb. tins	2 tins	2	6						
	,, ,, green, ,,	1 ,,	1	3						
	,, ,, red, ,,	1 ,,	1	3						
	,, ,, sienna, ,,	1 ,,	1	3						
	,, ,, blue, ,,	1 ,,	1	3						
	,, ,, re-transfer, $\frac{1}{4}$ lb. tins	1 ,,	—	5						
	,, ,, transfer writing	2 sticks	—	2						
	,, writing, black, 1 pint	1 bot.	2	13						
	Instruments, drawing, boxes of, G.S., filled	1 box	1	8						
	Knife, office	1	—	1						
	,, scraping	1	—	2						
	,, palette, 12"	1	—	6						
	,, paper	1	—	7						
	Pencils, lead, H.H.H.	6	—	$1\frac{1}{2}$						
	Pens, mapping	3 doz.	—	1						
	Penholders	1 ,,	—	$1\frac{3}{4}$						
	Pen, nibs, medium	1 box	—	$1\frac{1}{4}$						
	Plate, inking, 20" × 15"	1	9	9						
	Rollers, litho, 11"	1	10	—						
	Rulers, rolling, 18"	1	3	3						
	Saucers, ink, 3" diameter	6	—	7						
	Scissors, paperhangers'	1	—	5						
	Sponges, $\frac{1}{4}$-oz.	6	—	$4\frac{1}{2}$						
	Stone, snake, slips	2	—	1	49	$6\frac{1}{4}$	76	—	125	$6\frac{1}{4}$

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Details of Boxes—Cont.

No. of Box.	Detail of Stores.	Quantity.	Weight of Stores.		Total Weight of Stores.		Weight of Chests.		Total Weight.	
			lbs.	ozs.	lbs.	ozs.	lbs.	ozs.	lbs.	ozs.
6	Aprons, white	2	1	1¼						
	Acid, nitric, commercial	24 ozs.	2	13						
	Bucket, water, G.S., leather	1	4	11¼						
	Canvas, screen	12 yds.	2	12						
	Cloth, collar, white, 36″ wide	1 ,,	1	0						
	Kettle, copper, 3 pints	1	1	14						
	Oil, lubricating	1 qt.	2	12						
	Stone, grit	1 piece	5	12						
	,, snake	1 ,,	4	9						
	Turpentine, spirits of	2 gall.	23	0	53	2½	68	0	121	2½
	Varnish, litho, middle	1 qt.	2	14						
	Tent, telegraph	—	—	—	100	—	—	—	100	
						Total Weight			1381	

FIELD LITHO EQUIPMENT No. 2 (FOR PACK TRANSPORT OR LIGHT CART).

Details of Cases.

No. of Case.	Article.	Weight.		Total Weight.	
		lbs.	ozs.	lbs.	ozs.
1	Cotton, waste, white (1 lb.)	1	0		
	Ink, lithographic, printing, black, tins (1)	1	3		
	,, ,, ,, blue ,,		9		
	,, ,, ,, green ,,		9		
	,, ,, transfer, writing, sticks (2)		2		
	,, ,, printing, red, tins (1)		9		
	,, ,, re-transfer, ¼ lb. tins (1)		5		
	,, ,, printing, sienna, tins (1)		9		
	,, writing, black, bottles (1)		4		
	Muller, 2-inch	1	8		
	Paper, white, foolscap (1 ream)	14	0		
	Plates, lithographic, zinc, 17″ × 14″ (12)	28	4		
	Rollers, lithographic, 11-inch (3)	10	0		
	Sand, grey	6	0		
	Case for above (" tool, squadron, leather ")	17	0	81	14
2	Carriage, block and bar with leather strap	64	0		
	Case for above (" tool, squadron, leather ")	17	0	81	0
3	Bars	2	0		
	Cylinder	14	0		
	Eccentric shaft	5	0		
	Handle	3	0		
	Lever	4	0		
	Side frame of press (handle side)	36	4		
	Case for above (" tool, squadron, leather ")	17	0	81	4

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Details of Cases—Cont.

No. of Case.	Article.	Weight. lbs.	Weight. ozs.	Total Weight. lbs.	Total Weight. ozs.
4	Drivers, screw, general service, 9"		12½		
	Flour	2	0		
	Gall, solution	2	14		
	Gum Arabic	2	14		
	Paper, white, foolscap, reams (1)	14	0		
	Saucers, ink, 3" diameter		7		
	Scraper box, scraper, crosshead, pressure screw and spanner	27	0		
	Sponges, ¾-oz (6)		4½		
	Turpentine, spirits of (1 gall.)	11	8		
	Varnish, litho, middle (1 quart)	2	14		
	Case for above ("tool, squadron, leather")	17	0	81	10
5	Acid, citric		8		
	Aprons, white	1	1¼		
	Basins, evaporating (2)		9¾		
	Box, drawing instruments, G.S., filled (1 box)	1	8		
	Brushes { camel hair, No. 5 size (4) / sable hair, No. 1 size (4) }		1		
	Bucket, water, G.S., leather	4	11¼		
	Calico, white, dressed (20 yards)	6	2		
	Can, oil, lubricating, G.S.		6		
	Canvas, screen	2	12		
	Cloth, collar, white, 36" wide	1	0		
	Galls, Aleppo, whole		8		
	Gum Arabic	1	0		
	India rubber, eraser (1 piece)		½		
	Knife, office		1		
	,, palette, 12-inch		6		
	,, paper		7		
	,, scraping		2		
	Paper, glass, No. 2½ (sheets 12)	1	6		
	,, blotting (1½ quires)	2	0		
	,, tracing, red, foolscap		1¼		
	,, chalk red, foolscap (1 quire)		5		
	,, transfer—tracing, foolscap (2½ quires)		6½		
	Pen nibs, medium (1 box)		1¼		
	Pens, mapping (3 cards)		1		
	Pencils, lead, H.H.H. (2)		½		
	Penholders (1 doz.)		1¾		
	Potash, caustic (sticks)	1	0		
	Roller, lithographic, 11-inch:—Handles (1 pair)		1		
	Rulers, rolling, 15-inch	1	0		
	Scissors, paperhangers'		5		
	Side frame of press	35	12		
	Case for above ("tool, squadron, leather")	17	0	80	13
	Tent, telegraph (1)	100	0	100	0
	Total Weight			506	9

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The Field Litho Press No. 1 prints a sheet 18″ × 23″, No. 2 a sheet 13″ × 14″. There has been prepared besides these two a third pattern, "Field Litho Press No. 3," still smaller, for pack transport only. This weighs only about 160 lbs. and can be carried on one mule. It prints a sheet 14″ × 9″ ("foolscap" size). Remarks on Authorised Field Litho Equipment, etc.

These types of Field Litho Press have been very carefully worked out; but, I doubt if it will be found advisable to take lithographic stones on service in the field. They are very heavy and very easily broken. Undoubtedly stones are easier to work than plates and give better results—especially in hot climates; but, it is probable that expeditions in hot countries will require as light an equipment as possible; so that it will be impossible to use stones under the circumstances in which their superiority is most apparent. I think therefore that stones should be thrown out of the field equipment altogether. After all, with care and experience zinc plates will always give sufficiently good results—certainly with a hand-press. There is moreover to be considered the fact that a dozen or more plates can be carried for one stone.

I believe also, as I have already stated in this article (page 283), that it is very important to provide Survey Sections with some more rapid means of putting their field work in a form adapted for reproduction than by tracing-transfer, as at present proposed; and, if weight were saved by substituting plates for stones, apparatus for photo-process reproduction could be provided without much increasing the total weight of the equipment.

The additional equipment I would propose would be roughly as follows:—

Photo-process Equipment.

1 *Process Camera* (size adapted for normal field-sheet or for *half* such field-sheet).
5 dozen Process Plates, ditto, ditto.
2 Printing Frames (in cases), ditto, ditto.
1 Special Printing Frame for Vandyke Process, with spare glass, in padded cases (size adapted for normal field-sheet).
1 Small Oil Stove, with supply of oil in cans.
2 Lamps or Lanterns in boxes and 1 Lamp for developing.
1 Small "Dark" Tent with fittings complete, jointed bamboo poles.
Small Stores for photographic and process work, baths, etc.
Chemicals, etc., „ „ „ tabloid form.

"Sun-printing" Equipment.

2 Printing Frames, in special padded cases (size adapted for taking two field-sheets side by side).
5 Rolls Ferro-Prussiate Paper (French), "rapid."
5 „ Bemrose „ No. 4.
1 „ Calico for mounting Bemrose paper for use in field.
Chemicals (crystals) for sensitising paper for Ferro-Prussiate process.
Small Stores „ „ „ „
Baths, etc.

Map Linen or Pegamoid.

There appears to be no provision of any durable material for printing maps on for use in the field. All maps for this purpose should be printed on thin "Pegamoid" or other similarly prepared linen. The only

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satisfactory substitute is specially prepared thin tough paper. This has the advantages of being cheaper and lighter and easier to print on; but it is not nearly so durable as "Pegamoid." Four or five reams at least of "Pegamoid" should be taken if any considerable amount of map printing is anticipated. Though difficult to manage in a "machine," linen is easy to handle in a "hand-press."

Camera for Reconnaissance Work.

I would suggest also that a good hand camera, taking a long "panoramic" plate and with a special wide angle lens, should be provided for occasional reconnaissances. One of the officers and one or two of the N.C.O.s or men might be trained to use it and to develop and print from the plates. The space required for accessories, viz., plates, ruby lamp, celluloid baths, measuring glasses and chemicals, which latter might all be in tabloid form, would be inconsiderable.

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TRANSCRIPT.

THE AUTOMOBILE IN WAR.*

*From an article by "*Raiszner*" in the* Wien Militär-Zeitung *of 5th and 13th February,* 1906.

Automobile carriages have now reached such a stage of development, both from an engineering and a military point of view, that their general introduction into the Service cannot be much longer delayed. To an army in the field they will be of the greatest value.

In the great armies of the world a keen interest is felt in the development of the motor carriage, and in its perfection as a military machine. After years of experiment, their ideal has been attained, or nearly so. Not only has the machine been improved, but experience has led to a better understanding of it. The number of automobiles in use as pleasure carriages and for passenger and goods traffic is increasing every day.

The motor carriage has two great advantages over horse transport, namely speed and cheapness. The cost of its upkeep, including interest on prime cost, is relatively low. These two advantages will enable the motor to displace all other forms of road transport. And the manufacture of motor carriages on a large scale will lead to their being produced much more cheaply than at present, so that many persons now unable to keep a carriage of their own will be able to have a motor.

The general introduction of motor cars will revolutionize the conditions of military transport.

We learn from history that the transport of the supplies of an army has always been a most difficult matter, and that transport has often broken down at critical times with disastrous results. Even in the Franco-German War, where the organization of the transport columns was exceptionally perfect and the roads remarkably good, horse-drawn transport frequently broke down.

The latest war in which we Austrians have been engaged—namely, the occupation of Bosnia and Herzegovina—enabled us to realize to the full the difficulties of road transport. The roads were abominable, the weather bad throughout the campaign, and the country was flooded in many places. It was only by very heavy labour on the part of the troops, who had to build new roads and repair old ones, that these difficulties were overcome. But this meant a great waste of time and money. The

* *Communicated by the Chief of the General Staff.*

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expenditure for that campaign on hiring transport animals and carts, and indemnities for broken-down wagons and disabled horses, amounted to over a quarter of a million sterling.

Not the least of the advantages of motor transport is that it does not injure the roads, whereas horses' hoofs cut up the surface badly.

But the greatest military advantage of the motor wagon is that it shortens the transport column. Thus, one supply echelon of an infantry division consists of 72 country carts, carrying a net load of 32 tons and occupying 833 yards, or nearly half a mile, of road. It has 144 horses and 72 drivers, who have all to be billeted and fed. Set against this a modern Daimler road train, consisting of one tractor carrying 2 tons and drawing two trucks, each of which also carries 2 tons. One supply echelon would require four tractors with two trucks and two with one truck, total six tractors and ten trucks, taking up only 165 yards of road-space. The personnel would be reduced to 12 drivers. The road-speed of the supply echelon would be 6·2 miles an hour, except when marching with other troops, when it would have to conform to their pace.

The organization of the lines of communication, which is always a difficult matter, will be much facilitated by the increased speed of the motor wagon. Thus, one stage of the lines of communication of an Army Corps requires 3,000 country carts, 3,000 drivers, and 6,000 horses. These can be replaced by 60 tractors drawing 120 wagons, with 120 to 150 drivers and assistants.

The immense saving in expense effected by this reduction of the numbers of men and horses will be evident on considering the figures for the Bosnia-Herzegovina campaign. Although market conditions were favourable, since only a portion of the Army was mobilized, the cost of a ration in that campaign was 1s. 3d. and of a forage ration 2s. 0d. This includes cost of freight and transport. In the present case the saving would, at these rates, be over £1,000 a day.

If the *whole* army were mobilized, prices would be far higher than the above rates.

If we consider the reduction of personnel for a whole army, rendered possible by the substitution of motor for horse transport, we shall find that the saving on rations and forage alone would cover the cost and upkeep of the necessary road trains.

Moreover in the interests of agriculture it is economically sound to avoid taking large numbers of horses from the country to complete our transport for war.

Mechanical transport may be classified as:—

1. Traction Engines.
2. Motor Wagons.
3. Motor Cars.

TRACTION ENGINES.

These have been recently improved by the adoption of the compound engine, increase of boiler pressure, spring suspension, and in some cases spring-centred wheels. The driving wheels are broad and high, and the

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adhesion is sufficient to surmount steep gradients or roads slippery with ice. The road-speed may be taken at an average of 6·2 miles an hour. Any intelligent man can easily learn to drive a traction engine, especially since the machinery is simple and easy to clean and oil. These engines burn coal, coke, wood, or even peat.

The best traction engines are those made by Messrs. Fowler. These were used by the English in the South African War and did very well.

The principal objection to the traction engine is its great weight, namely 6 to 12 tons.

Traction engines require good roads and strong bridges. They therefore do not fulfil the conditions required of first-line transport. But they are well adapted for use on the road, especially on the lines of communication. They draw either two or three trucks, with a total useful load of from 12 to 24 tons.

But little attention is directed to the traction engine in modern armies, since the lighter motor wagon is better adapted to military purposes.

MOTOR WAGONS.

These are driven either by steam, paraffin, petrol, alcohol, or electricity. There are several varieties of each nature, as turned out by different manufacturers. The ideal motive power is electricity, which requires only light machinery. But electric current is only available in cities, and never in the field; while our present accumulators are so imperfect that 60 miles is the maximum distance which a motor wagon will run on one charge. There is therefore no likelihood of electric wagons being used in the field for some years to come.

At present petrol may be considered the best motive power for military purposes. The petrol motor is an explosion engine in which charges of petrol vapour mixed with air are exploded in the cylinders. The engine works on the Otto cycle, and runs about 400 revolutions per minute. Experiments are being conducted by several Powers with paraffin, alcohol, and steam; but in general the petrol motor is preferred, as giving the best results. It is lighter, more powerful, and more reliable than any of its competitors.

All motor wagons are much the same in build, and are characterized by a platform for the load and small wheels. The tare weight of a motor wagon is about 1·6 tons. Its speed is 6 to 7 miles an hour; this is because the machinery requires to be thoroughly cleaned after every 8 hours' running.

In the Austrian army we are trying the Daimler motor wagons, built specially for military purposes. These are manufactured in Vienna. They have four-cylinder petrol engines of 10 H.P. (nominal). Ignition is either by tube or by electricity. The average road-speed is over 7 miles an hour.

These wagons were at first built to carry a load of 5 tons. But the total weight was too great, and the present wagons are constructed to weigh 1·8 tons and to carry 2 tons. Besides this load the wagon will pull two trucks each loaded with 2 tons. These trailers can be uncoupled

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when passing over weak bridges, fords, or short steep gradients, and hauled over with the wire rope and drum attachment.

One driver and one assistant are required for each wagon and trailers.

Thus we see that by using these wagons as road trains their useful load is trebled. For this reason all the great foreign firms—such as de Dion and Bouton, Scott, Thorneycroft, Serpollet, and Mercedes—are building so-called military tractor wagons, constructed to pull a load as well as to carry one.

It must be remembered that the petrol motor is still a delicate machine, requiring a skilful driver and a highly-trained mechanic to keep it in order. This is a defect from a military point of view, since it will not be easy to provide the requisite number of trained chauffeurs. To overcome this difficulty we are now training a number of soldiers at the Daimler factory in Vienna.

Medium motor wagons, of a type between the 2-ton (light) and 5-ton (heavy) are being built in France and Germany as field ambulances, field telegraph wagons, and field postal wagons. We are also experimenting in this direction. Thus at the last manœuvres we had two field post-wagons supplied by Wyner & Co. of Vienna. One was a two-cylinder motor of 12 H.P. and the other a single-cylinder motor of 8 H.P. The first was equipped with boxes for letters and parcels, and was used for postal service between the Army Corps and the railway stations. The second was used to distribute letters and parcels to the various units, and covered 30 to 40 miles a day.

Motor Cars.

These are constructed principally for speed. The same applies to motor bicycles. They are used for the rapid conveyance of officers, for reconnoitring, and for forwarding orders and despatches.

Motor cars are of many different types, and are driven by petrol, paraffin, steam, or electricity. Petrol motors are almost universally preferred.

Racing cars, manufactured only for sporting purposes, are built of 100 H.P. and over, and are capable of the speed of an express train. But for ordinary touring cars 20 to 30 miles an hour is not an unusual speed.

France is easily at the head of the motor-car industry; she is followed by England and America. Germany has now taken up this industry, and has at present over 100 motor-car factories.

Motor cars and motor bicycles are of considerable military importance. They will be of great service for reconnoitring and forwarding orders and reports. They have been thoroughly tested at manœuvres during the last few years, and the work done by them has met with general approval.

Motor wagons are by far the most important of these vehicles for military purposes. They have not yet been thoroughly tried at manœuvres, since the experiments to determine the best pattern have only just been concluded. But at the next manœuvres we may expect to see a large number of these motor wagons both singly and with trailers.

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It is much to be desired that a thorough military test of motor wagons *at all seasons of the year* should be carried out. According to the newspapers, H.R.H. the Archduke Eugene was returning from the festivities attending the reception of the King of Spain in Vienna when his high-priced motor-car broke down on the high road between St. Polten and Melk. There was a light snowfall, and this was sufficient to choke the air-inlet valve. Such a car cannot be described as serviceable for war. A thorough military test of a vehicle must include its performance under all conditions of weather and at all seasons of the year.

We in Austria are on the right track. This is shown not by the motor-wagons which appear at our manœuvres, nor by the motor road trains which we have introduced at some stations for A.S.C. work, but by the remarkable progress made in the last two years by the Daimler company, working in harmony with our War Department.

An armoured motor-wagon carrying a Q.F. gun has lately been constructed by the above firm and tried in Austria, France, and Germany.

This wagon has a novel four-wheel drive, in which each wheel drives separately. The wheels are steel disc wheels with solid rubber tires. The hood over the motor, the radiator, and the driver's seat are armoured with steel plate. The driver sits in a steel cupola with a hole through which his head projects. But under fire he can lower his seat and his steering wheel, when he can see through eye-holes in the cupola.

At the back of the wagon is a hemi-spherical revolving steel turret containing a Q.F. gun. It is quite easy to load and fire the gun in any position.

This armoured wagon is said to travel 30 miles an hour. Its appearance is peculiar in that no driver is visible. Thanks to its four-wheel drive, it is capable (at least, so the makers claim) of running over all kinds of bad ground and of ascending slopes of 1 in 2, when the wagon appears to be on the point of overturning backwards. It is said to be capable of following anywhere where a field gun can go. This we beg leave to doubt.

In the present stage of development of the motor industry, motors may be usefully employed for the following purposes:—

1. Light covered wagons, built in military carriage factories, to replace hired transport for regimental provision wagons; also as ambulances, postal wagons, balloon and telegraph wagons, and Army Corps office wagons.

2. Motor wagons for the ammunition columns and train. This would shorten the columns very considerably and much facilitate supply service, and would also avoid the confusion and delay which results from putting in fresh echelons of hired transport every day. The shortening of the baggage train especially would be of the greatest advantage.

3. Motor wagons and traction engines for the lines of communication; the latter to be used only on good roads, where they will be of the greatest service. Both of these natures of transport may be used to connect the army with railhead, either of the permanent or the field railway; also to assist the field railway by doing part of its work.

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4. In fortress warfare traction engines and steam wagons may be used for transport of ammunition, supplies, and matériel, especially to outlying forts; also to work the dynamos of searchlights.

5. Motor cars and motor bicycles may be used, as already described, for conveying staff officers, carrying orders, reconnoitring, and similar purposes.

A wide field of utility is open to mechanical transport in war; and we may expect shortly to see it organized and developed, and taking its place in the ranks of the Army.

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REVIEW.

RAPID STATICS.

By FRANCIS RUFF.—(5s.).

MESSRS. E. & F. SPON have published an English translation of the first volume of a small German publication entitled "Reference Book for Statical Calculations," which contains force-diagrams and tables, etc., 'for all classes of building and engineering, for the practical use of boards of works, architects and engineers.' The author, a civil engineer of Frankfort-on-Maine, claims this to be 'the first attempt to present in a comprehensive and easily graspable manner the applications of statics to the constructions most frequently appearing in technical work.'

After some preliminary explanations regarding moments of inertia and resistance to bending of the cross sections most commonly used, and of the transverse forces and moments of application for simple beams under concentrated and distributed loads, the book deals consecutively with various descriptions of:—Trussed beams; Strutted frames; Roof trusses; Cantilevers; Open Web girders; Curved beams; Suspension bridges; Framed columns; Earth pressure; Vaults; Reinforced concrete constructions. Then follow tables of moments of inertia and resistance to bending of the *German* standard sections, including pillars; and finally miscellaneous information such as weights of materials, minimum thickness of walls of houses according to height, number of rivets required for angle and flat irons.

The diagrams and letterpress are very clear, and many of the solutions, notably those of fish-belly girders and jointed arches, are extremely good.

Engineers must, however, be fully acquainted with the metric system before they can use this book with advantage, and it is therefore unlikely to become popular in this country. But Mr. Ruff contends that the use of the metric system for calculations saves much labour and reduces the risk of error; so that the introduction of his books may perhaps form one more argument in favour of this system.

The second volume of the above work, of which also an English translation is to be made, deals with Machinery.

P. O. G. USBORNE.

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NOTICES OF MAGAZINES.

Cavalry Journal.

In the notice of the first number of the *Cavalry Journal* in our last issue, I omitted to mention that its Managing Editor, Lt.-Col. A. Leetham, late Captain, 13th Hussars, is a Sapper himself, being Major and Hon. Lieut.-Colonel in the Royal Monmouthshire R.E. Militia.

A. T. Moore.

Eenzhenernee Zhoornal.

July and August, 1905.

Road-Making and Bridging Work in Manchuria.—A short article mentions four sections of the road constructed by the Russians during the recent war under the superintendence of different officers:—(1) between Liao-yang and Mukden, (2) between Liao-yang and An-shan-chan, (3) between An-shan-chan and Hai-cheng, and (4) between Hai-cheng and Yen-kow. The author himself was responsible for the third, which he describes.

The existing mandarin road, a hollow way badly drained and presenting in most places a sea of clinging mud, was unsuitable for military purposes. The Russians took the precaution of making in its stead three almost parallel roads, one by the side of the mandarin road and in a few places coinciding with it, a second to the west of the first and near the railway, and a third to the west of the second. The distances between the roads varied from one to four versts.*

The soil of the country traversed by these roads was mostly stiff clay or sand, and the writer does not mention any rock-cutting difficulties. His attention was confined chiefly (1) to the cutting of a very thorough system of drainage, and (2) to strengthening the surface of the new roads, for which much use was made of the stout stalks of the kowliang—the high-growing corn which played such an important part in the tactics of the Manchurian battles. The latter arrangement was especially necessary where the road was to be used by country carts, as the large nail heads which projected from their tyres were particularly destructive to road surfaces.

The sections of the roads show them to have been from 16 to 23 feet wide, with ditches on both sides and very little camber.

* 1 verst = ·66 of a mile.

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A careful reconnaissance of the ground having already been made, the writer started work without delay on the 13th April, 1904; and with the help of an engineering staff of 2 officers and 32 N.C.O.s and sappers (which allowed, after deducting a small guard, about 1 officer and 8 N.C.O.s and men to each track) he was able to carry forward all three roads at the rate of two versts a day.

The work was of course carried out by Chinese coolies, who seem to have been rather unmanageable in large numbers. They were found to give better results when engaged individually (by the help of an interpreter) than through contractors, who probably defrauded them of half their earnings. They also not unreasonably objected to be paid in paper money. They were organised into parties for separate duties, such as tracing and cutting drains, building culverts and small bridges, cutting and spreading gaolana stalks, spreading earth and rolling. The cost of a verst of road, after experience had shown how it could be done most cheaply, worked out at between 50 and 80 roubles* according to the nature of the ground.

One feature of the country may be mentioned, the number of Chinese burial grounds, each containing about 20 tombs, for every family has its private cemetery. As there was every reason for conciliating the country folk as much as possible, it was generally arranged to divert the road so as to avoid these graveyards; but where, owing to the nature of the country, this was found to be impossible, compensation was arranged for at the rate of 3 roubles a tomb, a precedent for this having been established during the construction of the railway.

The writer was employed later on in constructing the military roads within the Liao-Yang defences, where a fairly complete system of communications seems to have been arranged. In this case it was found that Chinese labour was not available, all the Chinamen having been taken for work on the defences. Consequently military labour was employed; but this seems to have been an exception in the Russian army, and a special arrangement was made for the issue of working pay to the junior ranks.

In the portion of the article referring to bridging works a detailed description is given of a bridge built across the Tai-tse at Liao-yang The river was subject to floods and sudden changes of level, and a shifting sandy bottom made it unsuitable for trestle work, for which also the time and material available were insufficient. However junks were available in sufficient numbers and seem to have made very suitable substitutes for pontoons. These junks were about 26 feet long and 5 ft. 6 in. beam, and when unloaded the decks were about 3 feet above the water line. The writer calculates that their displacement, leaving a safe freeboard of 1 foot, was 600 poods or 21,975 lbs., but there are several misprints in the numbers quoted in the article and possibly this may be one.

The boats were overhauled and strengthened, especially in the bows, and improvised saddle beams were built up along the centre of each. The

* 1 rouble = 3s. 1d.

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baulks available for road bearers measured 24 feet × 10 inches × 7 inches. With spans of 23 feet it was calculated that five road bearers would be sufficiently strong to carry field guns and moving infantry, the weight of the latter being taken as 60 lbs. per square foot. The baulks meeting over the saddle beams were bolted together in pairs, and one of each pair was bolted down to the saddle beam. The bridge was chessed with planks specially sawn in the Liao-yang railway workshops. The junks were moored up and down stream by 2-inch ropes to anchors or piles. A cut raft was prepared in the fairway near the left bank, and an ingenious arrangement was devised for breaking up the roadway to enable cut to be formed rapidly.

The breadth of the stream was 706 feet, and including the cut raft 35 junks were used in the bridge and 5 more were kept in reserve. The shore end on the right bank was trestled.

The bridge was built entirely by Sappers and Pontoniers and was finished in 12 days, but there was some delay both in making the bolts and in sawing the planks. The cost was 14,189 roubles, the junks being purchased at an average price of 200 roubles apiece.

Mention is made of a trestle bridge, of over 200 feet in length, across the Fan-tse, and of 16 other small trestle bridges of 70 feet and under. In the absence of planks suitable for chesses the roadway was made of light poles laid across the road bearers with bundles of kowliang straw laid on them and a layer of earth over all.

At Hai-cheng, on the river of that name, the Sappers made two bridges of trestles, as junks could not be brought up to the sites; no details are given of these bridges, except that some of the trestles were strengthened by being lashed with wire to piles driven in alongside. These bridges unfortunately had to be burnt two days after they were finished, owing to the retreat of the Russian army from Hai-cheng.

F. E. G. SKEY.

NATURE.

February, 1906.

THE GECKO (*p.* 322).—The Victorian *Naturalist* of December, 1905, mentions that the diamond-tailed Gecko (*Phyllurus platurus*) is always found head-downwards on the rocks it frequents. They assume this position, in order to make hawks believe that their heads are their tails; consequently, when seized by one of these birds, which invariably pounce upon what they regard as the head, the brittle tail snaps off, and the wily gecko wriggles away, little or none the worse for the encounter.

ELECTRIC FURNACE (*p.* 325).—Professor Moisen has continued his experiments on the fusion and volatilisation of the more refractory metals in the electric furnace. With a current of 700 ampères at 110 volts in 5 minutes platinum could be distilled with great ease, the liquid metal

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distilling with the same facility as water carried to 100° C. Palladium, iridium, and rhodium were also fused and distilled without difficulty.

THE INTRODUCTION OF REINFORCED CONCRETE (*p.* 350) marks a new epoch in the history of building. One of the most remarkable applications is its use for the construction of dams. This method of building a permanent masonry dam, at a comparatively low cost, has already rendered financially practicable the utilisation of many water-power sites which otherwise would have been neglected.

THE FIXATION OF NITROGEN (*p.* 355).—Sir William Crookes pointed out in 1898 that there will be a wheat famine in 50 years unless the world's yield per acre (at present about 12·7 bushels on the average) can be raised by use of fertilisers. Of such fertilisers the chief is nitrate of soda, exported from Chili, the supply of which at the present rate will be exhausted in less than 50 years. Then, the only chance of averting wheat starvation lies through the laboratory. Lord Rayleigh in 1895, by forming an arc between platinum poles, in an atmosphere of air to which oxygen had been added, and absorbing the oxide of nitrogen, formed by causing a fountain of caustic soda solution to play on the top of the flask containing the arc, produced a mixture of nitrate and nitrite of soda; the result being about 7 litres of mixed oxygen and nitrogen per hour; but no commercial process had been found practical for the synthesis of nitrates from the air till a Norwegian Company, in 1905, started a factory at Notodden, where the neighbouring waterfall now in course of utilisation will furnish 25,000 horse-power. The yield of nitric acid per year is said to be more than 500 kilograms for every kilowatt of power. The new product can now compete with Chili saltpetre on the market, and will become every year more valuable, as the demand for nitrates increase and the natural supplies become exhausted.

GRANULATIONS ON THE SOLAR SURFACE (*p.* 401).—An interesting research concerning the nature of the sun's photosphere has been instituted at the Pulkowa Observatory. Eight consecutive photographs with intervals of 15 to 30 seconds duration were taken. These show very plainly the changes taking place in the sizes and relative positions of the granules. The displacements of the granules in a few seconds were very diverse; some were found to be moving at the rate of 38 kilomètres per second, and some at the comparatively low velocity of 14 kilomètres per second. The dimensions of the granules varied greatly between 670 kilomètres and 2,000 kilomètres. These researches may lead to most important conclusions concerning the nature and the periodicity of the changes in the granules themselves, their influence on the solar spots and faculæ, and to the re-solution of many outstanding problems, concerning the nature and action of the photosphere, which are at present unsolved.

SOLDIERS' STATURE IN WAR (*p.* 414).—The Japanese had an unquestionable advantage in the recent war by being smaller than the Russians; they were smaller targets for firearms. Bullets are, on the average,

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uniformly distributed over the target presented by a man's body, they come from all directions, front, rear, and flanks, so that a man presents a target proportional in area to the square of his height. The Anthropological Institute gives the average height of the Japanese soldiers as 1,585 millimètres as compared with an average of 1,642 millimètres of the Russian conscripts. The average targets offered by each to the enemy are, therefore, as the squares of 1,585 and 1,642, or as 100 to 108, an advantage to the Japanese of about 8 per cent.

W. E. WARRAND.

ORGAN DER MILITÄRWISSENSCHAFTLICHEN VEREINE.

No. 2, Vol. XXII.

MILITARY BALLOONS IN THE RUSSO-JAPANESE WAR.—The Russians had two types of balloon, spherical and elongated. The first was of French make and was of varnished material; the latter was made in Germany, the material being treated with rubber. The rubber material became hard and brittle in cold weather.

The elongated balloon was not steadier than the spherical and was too large to be man-handled in a strong wind. The winding engine for the cable had to be left behind as it was too heavy to be brought over the Manchurian roads. The French spherical balloon was much used. It was hit several times, once by a shrapnel, but only five small holes were made in it.

The Russians made their gas *in situ*. They first used scrap iron and sulphuric acid for generating the gas, but these were found to be too heavy so a lighter pattern of generator was adopted. In this the gas was made from aluminium and caustic soda. The charge for a balloon (spherical ?) was 600 cubic mètres of gas; and required either 2,200 kilos. of iron and 2,900 kilos. of sulphuric acid, or 550 kilos. of aluminium and 1,000 kilos. of caustic soda.

It was found almost impossible to observe shrapnel fire accurately from a balloon, but this difficulty did not occur with common shell.

The Japanese balloons were elongated and carried a three-cornered sail. The type was not satisfactory. During the siege of Port Arthur the Japanese balloons never came within 8,000 mètres of the fortress and consequently did not accomplish much.

J. E. E. CRASTER.

REVUE D'HISTOIRE.

February, 1906.

CAMPAIGN OF 1794.—*Army of the North.*—The progress of the siege of Landrecies and the attempts of the French to raise it are described. One of these attempts led to the action of Villers-en-Cauchie, where four

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squadrons of light cavalry (two British and two Austrian) routed twice their number of French cavalry, and broke a square of six battalions.

PURSUIT OF THE ENGLISH ARMY BY MARSHAL SOULT.—The series of articles on Napoleon's campaign in the Peninsula is brought to a conclusion by the battle of Corunna. Commandant Balagny claims that the French had the best of the fight; but it was begun too late in the day, and the proportion of troops engaged was too small for any decisive success. At Corunna, as at Lugo, Soult showed himself too cautious, not to say timid. He had the excuse that he was inferior in numbers to the English, and their escape was mainly due to Napoleon's decision at Astorga not to send on Ney with Soult.

WAR OF 1870–1871.—*The Army of Chalons.*—Owing to the capture of a staff officer who was the bearer of fresh instructions from Macmahon, Failly's Corps pursued its march on Stenay, and came in collision at Nouart with the advanced guard of the Saxons on August 29th. After dark Failly turned his corps northward, and in the course of the night it reached Beaumont, but men and horses were utterly exhausted. To retreat on Mézières or to push on towards Metz seem to have been the only alternatives entertained by Macmahon. The writer suggests that a vigorous attack on the nearest German corps would have been better than an attempt to slip past them.

E. M. LLOYD.

RIVISTA DI ARTIGLIERIA E GENIO.

January, 1906.

RUSSO-JAPANESE WAR.—An article by Capitano d'artigliera Luigi Giannitrapani gives a general account of the operations in Manchuria in 1905 and of the strategy and tactics of the contending armies, and contains several technical matters of interest to the Engineer Corps of the two armies.

Field Kitchens.—The very rigid winter at the commencement of 1905 was one of the severest on record, the lowness of temperature being aggravated by severe dust and snow storms. The comparatively good sanitary conditions of the Russians during this period is ascribed to the use of field kitchens on wheels, by means of which hot rations could be served to the troops twice during the day, at dawn and sunset.

These field kitchens, capable of carrying about 200 rations, were of two kinds, one for infantry and the other for cavalry, the former on four wheels and the latter on two. A sketch of these field kitchen carriages is given on p. 16.

Balloons.—The Russians at this time—the early part of 1905—made use largely of balloons for observing the enemy's positions. Sometimes clouds of smoke were created by the Japanese in order to impede the

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observations of the enemy's aeronauts. Two balloon companies were attached to the newly-formed battalions; and the third was the balloon company of Eastern Siberia which had previously been stationed in the theatre of war. The Japanese fired at the balloons with shrapnel and shells provided with time fuzes, but without result according to the Russian accounts. Some ascents were made by the Russian balloonists, even at night time, but the officers engaged assert that these ascents were made under great difficulty owing to the low temperature. Photographs of the balloons in use by the Russians are shown at p. 18.

The Japanese at this time did not make use of balloons; they carried on their observations of the enemy's positions from observatories established in the villages, from trees, or from any eminences in the plains. From these observatories very important vigilance was exercised. Flag signalling was carried on from these posts by day. By night the electric light was used, with coloured light, on a system similar to that in use by the navy.

At this time several small skirmishes took place between the advanced guards and the isolated patrols in front of the Hun as far as Biamupusa, in which locality there had been combats of some importance at the end of 1904 between the troops of the more advanced detachments. The Japanese battalions were disposed with only three companies in the lines of the trenches, the fourth being located behind a village during the day but brought to the front at night. By day each battalion was covered by sentries placed in elevated observatories and by night by watching patrols. If the Russians were not seen, notice of their approach was given by the baying of a dog which was always kept at a small post in the vicinity. On discovering the patrols the alarm was given by whistles or rifle shots.

Battle of Sandepu.—The battle of Sandepu lasted from the 25th to the 29th January without interruption in the midst of a snowstorm, the temperature which followed the mild period from the 5th to the 20th January being very low at this time. The battle commenced by an attack made by the right of the 2nd Russian Army Corps, during which the enemy, taken by surprise, had to abandon their more advanced positions. This was followed by a vigorous counter-attack by the Japanese, which paralysed the Russian movement. The Russians then remained in this position for three days, from the 26th to the 28th, during which an uninterrupted series of local combats took place, ending by orders from superior authority being received on the evening of the 28th for the retreat of Grippenberg's army.

The Japanese forces engaged in this battle, according to approximate calculations, amounted to about 40,000, against 58,000 Russians. But the first day (the 25th) there were about 3,000 rifles scattered in the villages, which had before them at a very little distance the Siberian Corps on the west and north and the 14th Division with 30,000 rifles and 14 field batteries.

The losses suffered by the Russians in this disastrous battle were very great. According to Russian sources the total loss of officers killed, wounded, and prisoners amounted to 6 generals—among whom were

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Generals Mischensko and Kondratovisch—and 400 other officers. After the battle there were found at Mukden about 8,400 wounded men, but the number of men killed, of wounded recovered from the Japanese, and of prisoners is not known. From all the information obtainable it may be deduced that the total loss of the Russians amounted to about 13,000 men. The effective force employed by the 2nd Russian Army was limited to the 1st Siberian Corps, the Mixed Corps, and the 14th Division, calculated at about 52,000 men, to which may be added about 6,000 men of Mistchensko's cavalry. The losses were thus about 24 per cent., a notable proportion. The causes were probably—dense formations, the difficulty of obtaining cover owing to the hardness of the ground, distinct visibility at a distance owing to the snow, and lastly climatic conditions.

The losses of the Japanese, according to reliable data, amounted to 9,400 killed, wounded, and missing, among whom were 353 officers. Since the force consisted of two entire divisions (8th and 5th), a reserve brigade, and a cavalry brigade, there was a total of about 40,000 men engaged; so that the proportion of their losses was also about 24 per cent., this figure being an increase over the losses sustained in previous battles, owing (among other causes) to the climatic conditions and to the obstinate resistance opposed by an enemy superior in numbers.

THE FUTURE OF HYDROPLANES.—*La Vie Automibile* of 23rd December, 1905, contains the following ideas of Sigr. Erneste Archdeacon on the construction of the apparatus called the hydroplane.

The constructors have long been aware of the great difficulties that are met with in increasing the velocity of boats, owing to the resistance of the water, and because the force required for propulsion increases in boats of the ordinary form in the ratio of the cube of the velocity. During late years they have succeeded in considerably increasing the velocity of automobile boats by making them of a less fishlike form, so that while the velocity is increased the resistance of the water is much less than before. It is calculated that in boats of the latest model, by diminishing the fishlike structure, the retardation caused by the resistance of the water may be diminished 33 per cent. Two years ago the Count di Lambert succeeded in constructing a boat by which the resistance of the water was not only reduced 33 per cent. but was so completely suppressed that it scarcely offered any resistance.

The principle that guided the construction with such a result is stated to have been discovered many years ago by Mons. Pictet of Geneva, who experimented on the lake of Geneva with boats the framework of which was provided with inclined planes. The boat constructed by di Lambert, although it is heavy and in some respects defective, is capable of attaining a speed of 35 k.m. an hour with a motor of 13 h.p.

The theory of the hydroplane is in other respects similar to that of the aeroplane, and is based on the fact that, whatever may be the inclination of the planes, it remains horizontal in a fluid—air or water—subject to an ascending or descending reaction in regard to the forward movement.

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Now the hydroplane is merely a boat to which is attached a series of planes placed at convenient inclinations. At the commencement of the movement the pressure of the water on the apparatus and its retardation are at a maximum. But it has scarcely commenced to move when an ascending movement also commences, which — if the velocity is sufficient — is not arrested until it has regained a position in which, as long as it is acted upon, the retardation becomes decreased and finally annulled. In Count di Lambert's boat the inventor calculates that the ascending movement is complete when it reaches a velocity of 15 k.m. Beyond this limit the force necessary for the propulsion of the emersed hydroplane increases exactly as the velocity. This however is only as long as the velocity does not become very great, since the resistance of the air is not taken into account. To obtain the given speed of 15 k.m. for the boat in question a 6-h.p. motor is used; from which the speed of a boat provided with a motor of 40 h.p. is calculated to be 100 k.m. an hour. This value is subject to a large reduction owing to the resistance of the air. The Archdeacon, after combating the objections that it would be difficult for a hydroplane to move in water not perfectly smooth, gives drawings and explanations of the method of arranging the planes, of their position in the boat, and of the method of supporting the propellers, etc.

E. T. THACKERAY.

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CORRESPONDENCE.

OUR IDEAS ON PERMANENT FORTIFICATION.

DEAR SIR,

I write to thank Capt. G. Walker for his friendly criticisms in the last number on my article in the January issue, and to a certain extent make a short reply to them.

I must say that I started my article with the idea that our ideas were in some respects wrong, but I think my article shows that I modified my opinion.

As to the plans generally I came to the conclusion, when I had finished them, that they were a very unsatisfactory solution of the problems I had set before myself; but rather than throw away the results of some three weeks' work I let the whole article stand, in order, as Capt. Walker remarks, "to induce others to take a hand in the discussion." I wish some R.E. officer, who is on leave or has some leisure, would design a type fort or redoubt and let us have the result.

I quite agree, now, with Capt. Walker that electric lights should not be placed in the works but in flank positions, which should be changed from time to time; otherwise the electric lights will only serve as guides to assaulting parties.

Perhaps what the Corps really wants is a "Manual of Permanent Fortification," which should be divided into at least two volumes and brought up to date from time to time. There are official manuals on almost every duty nowadays. Why should there not be one on this important subject, which has fallen so greatly into neglect of late? Colonel Lewis's invaluable book would form a very sure foundation on which the official edifice might be built.

Yours truly,

H. E. G. CLAYTON,

Major, R.E.

The Editor, "R.E. Journal."

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NOTES ON SHELTER TRENCHES.

SIR,

There are a few points in Colonel Capper's able "Notes on Shelter Trenches," published in the March number of this *Journal*, which seem to require further discussion.

In the preface to the *Manual of Military Engineering*, 1905, are the following words:—

"Officers and N.C. Officers in charge of works should, while bearing the principles in mind, learn to modify the types according to local conditions."

Now the principles running through this book are many, and the first is—that the position to be defended must be chosen with regard to 'tactical requirements.' It seems to me that, if this rule is assimilated, no officer, when arranging a rear-guard action, will place his men in a position from which they cannot be retired. If rules are required for all and every occasion the text-books, already fat enough, would become quite corpulent,—something must be left to teaching and to reason. 'Intelligence' even 'untaught' would in the circumstances cited by Colonel Capper have done the 'obvious' thing in practice. It was the imagination required for the good working out of an imaginary situation that was lacking. The man without intelligence, taught or untaught, will go wrong sooner or later, however many rules have been laid down. For such the text-books cannot legislate.

Colonel Capper's contention that "if the attack is able to advance over *open ground* to within a very short distance of the trenches he will *in all probability** be successful" is without doubt borne out by facts, for most unsuccessful attacks over such ground both in the South African and (apparently) in the Russo-Japanese War fizzled out at, say, 800 yards from the trenches. But the italics are important; probabilities are not good enough where principles have to be laid down. A good many instances can be found where attacks over open ground failed in the last 200 or 300 yards. At Paardeberg half a battalion of the Duke of Cornwall's Light Infantry and, I think, some of the Seaforth Highlanders attacked over fairly open ground, and were stopped only 200 yards from the Boer trenches. At Nanshan the Japanese got to within 200 yards of the Russians and then made several unsuccessful charges, officers and men falling within 20 and 30 yards of the enemy. At Shu-shan-pu (south of Lioa-yang) there was more than one instance where the Japanese got close up and then failed. In the attack of one of the redoubts round Liao-yang the Japanese infantry, attacking over open ground, got to within 200 yards, and there had to wait till night before the final assault could be made.

The fact is the expression 'open ground' is indefinite. So-called open ground is often deceptive, and affords a good deal of cover to skilful men where the casual eye would say none existed.

* These italics are mine.

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But besides open ground another condition is essential to stay the attack, and that is good shooting on the part of the defender; and this good shooting depends very greatly on the amount of covering fire the attacking artillery and infantry are able to develop. If this supporting fire is as good as it should be, and if the defenders have not had time to make head cover or over-head cover, the attacking infantry may, even over open ground, get close up to the trenches without serious loss. But this covering fire has to cease sooner or later according to the configuration of the ground, and it is then the defender gets his chance. To defeat this chance it is the aim of the attack to bring an overwhelming force to within charging distance. The 200 yards of dead ground permitted by Colonel Capper should enormously facilitate this final stage, making as it does a convenient breathing place before assault.

Had there been this zone of safety in the instances quoted above, is it not at least possible that the attack in each case would have got home?

At Talana, Belmont, Graspan, Alemand's Nek and many of the earlier battles of the Boer War the ground immediately in front of the Boer positions gave fair cover and anxiety on our side was pretty well over when that ground was reached.

The best site for a fire trench is often a debatable point; for the circumstances of tactics, ground, morale, and fire effect vary so much that only experience can decide on the best position in each case. But I maintain—in fighting a civilized enemy at any rate—one principle should be that, if the contour of the ground involves 'dead' ground immediately in front of a trench, this dead ground must "not only at night and in misty weather" but in all cases be swept from another position. In fact the principles laid down in *Manual of Military Engineering*, Sections 1 and 66, and in *Instruction in Military Engineering*, Part I., paras. 132 to 136 must be applied—with common sense.

Coming to 'concealment' it seems to me doubtful whether at "very close ranges" the *defending firing line*, unless very weak and extended, will gain much protection from mere bushes, for the concealment of a position at very close ranges is hardly possible. The attacking fire at these very close ranges is likely to be anything but aimed. There should at this stage be a storm of attacker's bullets sweeping the defended area, a great many of which will find their billets unless the defender is covered by something more bullet-proof than a hedge. The instance quoted by Colonel Capper where the Boers attacked a few men in some outlying trenches does not seem to be quite applicable to the case under discussion. These Boers were attacking and had got up to close range through scrub at night; their position then could not definitely be known. It was a case of a few men on an extended front.

Colonel Capper seems to me to rather deprecate the use of loopholes and gives good reasons, but if there is one thing we Engineers have learnt from the late war it is the importance of head cover and over-head cover. At Port Arthur the Russians at first made open trenches, but they soon found that over-head cover was essential. Miles of it were made, and many of the positions so defended were held against very strenuous attack. Both sides found head cover a necessity at close ranges.

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But it is not only against rifle bullets that head cover and over-head cover are useful, but most particularly against the modern shrapnel. Since it is the object of the guns of the attack to keep the defenders' heads down, it is only by giving adequate protection that we can hope to keep them up. Tufts of grass or bushes to hide heads are of course very desirable, and better than nothing, but where material and time is available something stronger should be attempted. The statement that "At ranges at which a man's head would be visible, men firing over a parapet, with their heads merely concealed from the enemy's view, will probably not suffer more than the same number of men firing through clearly seen loopholes" requires proof; it depends on the class of loop-hole made and on whether the fire is direct or oblique.

Yours faithfully,

G. M. HEATH,

Lieut.-Colonel.

The Editor, "R.E. Journal."

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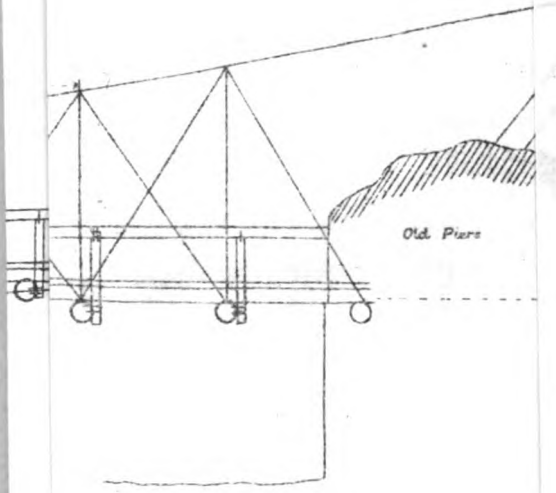

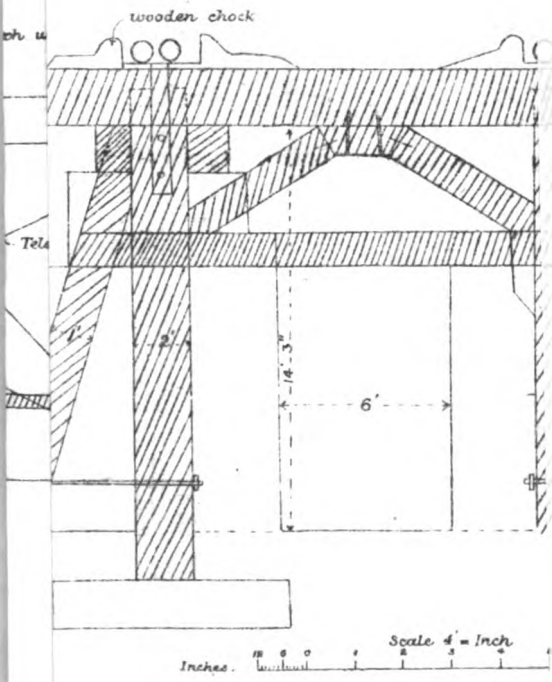

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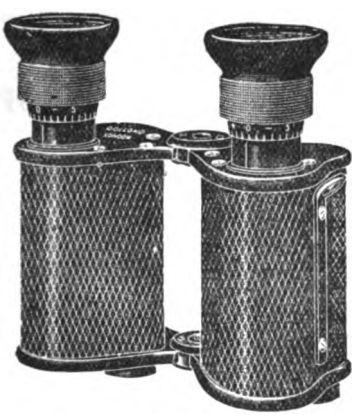

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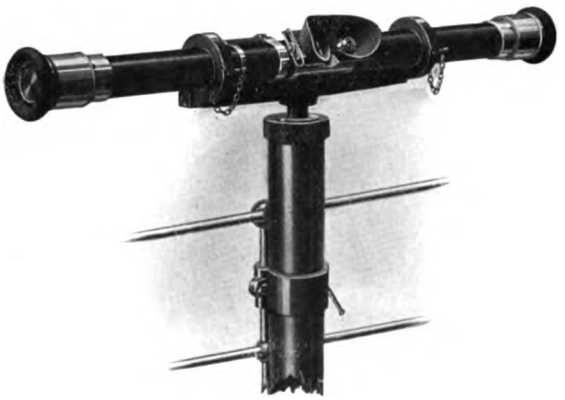

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*THE FRONTIERS OF THE BRITISH EMPIRE.**

By T. MILLER MAGUIRE, LL.D.

THE true frontier of a power which has command of the sea, with regard to any great Continental power which it opposes, is the coast line of the enemy.

Thus in 1801—1815 the British were able to threaten or bombard or blockade all the leading strategic or commercial points from St. Petersburg to Genoa and thence to Alexandria. Between 1805—1815 our fleets landed forces where they pleased from Java to Ceylon and Mauritius, the Cape, South America, the West Indies, the Potomac, Copenhagen. All through the British had their frontiers across the seas for all purposes of hostile expeditions; and all through the Peninsular War our sailors enabled our soldiers to "take as much or as little of the war as they pleased" from Tarragona to Cadiz and from Lisbon to Bayonne. The fleet facilitated and secured alike the retrograde strategic retreat of Moore in 1809 and the advancing change of base of Wellington in 1813. Nor did our naval power defend our Isles from invasion by a passive defence in the Channel. From this point of view also they turned hostile coasts into the British frontiers.

It is a strange delusion that any lecturer on the Art of War in England would be so foolish as to disparage our naval power even before an audience of soldiers. The Royal Engineers know just as well as any Blue Sea or Yellow Sea or White Sea or any other Sea fanatic that in an empire like ours sea power is vital; and also that it produced precisely the same effect in our wars in the days of Raleigh, Blake, and Rodney as in the days of Nelson.

But let us hearken to a foreign authority on our

COMMAND OF THE SEA.

The following extract from the great work by Capt. Mahan, United States Navy, shows how the command of even distant seas affects the chances of invasion.

* Our best thanks are due to Dr. Maguire for writing out the main portions of a Lecture delivered *ex tempore* at the Royal Engineers Institute on 19th October, 1905. The Lecture was illustrated by numerous maps and photographs, but can be followed on the Navy League map of the British Empire.

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"Meanwhile that period of waiting from May, 1803, to August, 1805, when the tangled net of naval and military movements began to unravel, was a striking and wonderful pause in the world's history. On the heights above Boulogne, and along the narrow strip of beach from Etaples to Vimereux, were encamped 130,000 of the most brilliant soldiery of all time, the soldiers who had fought in Germany, Italy, and Egypt, soldiers who were yet to win, from Austria, Ulm and Austerlitz, and from Prussia, Auerstadt and Jena, to hold their own, though barely, at Eylau, against the army of Russia, and to overthrow it also, a few months later, on the bloody field of Friedland. Growing daily more vigorous in the bracing sea air and the hardy life laid out for them, they could on fine days, as they practiced the various manœuvres which were to perfect the vast host in embarking and disembarking with order and rapidity, see the white cliffs fringing the only country that to the last defied their arms. Far away, Cornwallis off Brest, Collingwood off Rochefort, Pellew off Ferrol, were battling the wild gales of the Bay of Biscay, in that tremendous and sustained vigilance which reached its utmost tension in the years preceding Trafalgar, concerning which Collingwood wrote that admirals need to be made of iron, but which was forced upon them by the unquestionable and imminent danger of the country. Farther distant still, severed apparently from all connection with the busy scene at Boulogne, Nelson before Toulon was wearing away the last two years of his glorious but suffering life, fighting the fierce north-westers of the Gulf of Lyon, and questioning, questioning continually with feverish anxiety, whether Napoleon's object was Egypt again or Great Britain really. They were dull, weary, eventless months, those months of watching and waiting of the big ships before the French arsenals. Purposeless they surely seemed to many, but they saved England. *The world has never seen a more impressive demonstration of the influence of sea power upon its history.* Those far distant storm-beaten ships, upon which the Grand Army never looked, stood between it and the dominion of the world. Holding the interior positions as they did, before—and therefore between—the chief dockyards and detachments of the French navy, the latter could unite only by a concurrence of successful evasions, of which the failure of any one nullified the result. Linked together as the various British fleets were by chains of smaller vessels, chance alone could secure Bonaparte's great combination, which depended upon the covert concentration of several detachments upon a point practically within the enemy's lines. Thus, while bodily present before Brest, Rochefort, and Toulon, strategically the British squadrons lay in the Straits of Dover, barring the way against the army of invasion."

Ought not these sentences to be dictated to every school boy and school girl in our Empire ?

But sea power ceases at the shore; landing parties and soldiers complete the work of the Navy. Both Navy *and* Army are as necessary for our Islands and for their enormous over-sea territories, for the safety of our own people (40,000,000), our white colonials (12,000,000),

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and our darker fellow subjects (350,000,000) as are father and mother to the perpetuity of a family.

"Through sea power we hold the gorgeous East in fee."

Before going to the East I think I had better describe the present strategical position of Canada and the West Indian Islands. My authorities are deliberately chosen, they are all American. Mr. Bancroft, whom I will quote later on, is an eminent literary man and publisher, Colonel Wagner a Regular Army officer, and Capt. Mahan an illustrious Naval officer.

I. PACIFIC SLOPE OF CANADA.

The Pacific Slope of the Dominion may be dismissed from our consideration in a very few words. In one sense, British Columbia is more exposed to invasion than Canada proper, the boundary line being mainly an artificial one; but the roads leading across the frontier are few and poor, the only railroad in the province would not lend itself to the supply of an army operating from the south, and there is no objective in the main portion of the province of sufficient importance to justify military operations of any magnitude. The two points of special importance, Victoria (the capital) and Esquimalt (the great naval station), are both on Vancouver Island, safe from attack so long as England maintains her supremacy on the sea.

ONTARIO.

The southern, or most populous, part of Ontario is, generally speaking, a plain, though it is very undulating, and along the shores of Lakes Erie and Ontario is in many places broken by shelving rocks and precipices. The province is often termed "The Garden of Canada" and is a region of surpassing fertility. Its average yield of wheat, oats, and barley exceeds that of our best States. It produces fruits of various kinds in great abundance, is without a superior as a sheep-raising country, and its exports of cattle and bread-stuffs are large.

The province is generally well cultivated and has fairly good roads. On the whole it is well suited to military operations. The heavily timbered region lies almost altogether north of the probable theatre of operations; and the products of the province would greatly facilitate the supply of an invading army.

QUEBEC.

In the province of Quebec, wheat, barley, oats, rye, and hay are produced in large quantities, and the exports of cattle and beef are considerable. "Dense forests cover enormous tracts of territory"

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and the province, as a whole, is heavily wooded. The country has a great number of good wagon roads. Artillery could thus be easily transported; but owing to the mountainous and wooded nature of the province an invading army would, doubtless, require a minimum of artillery and cavalry and a maximum of infantry. The products of this province, too, would greatly facilitate the supply of armies operating in it.

NEW BRUNSWICK.

Except in the mountainous regions already referred to, the surface of New Brunswick is generally undulating. Though the country is not infertile, the agricultural products are not sufficient for home consumption. Hay is produced in great quantities, but the province is not suited to the operations of cavalry or the extended use of artillery, being one of the most heavily wooded regions in the world. The supply of an invading army would receive scanty assistance from the products of this province, and its operations would be impeded by natural features which would lend great advantages to the defence.

NOVA SCOTIA.

Nova Scotia is a more productive province than the one just considered, cereals and fruits growing in abundance. The country contains extensive forests, but its roads are numerous and of excellent quality. The obstacles that would be encountered by an invading army would, however, be found in other natural obstacles than those yet considered.

CANALS AND WATERWAYS.

There is another waterway of less importance perhaps than the Welland and the St. Lawrence canals, but which may nevertheless be of great value to Great Britain, or perhaps to the United States, in case of war between the two nations. Forty-six miles below Montreal is the mouth of the Richelieu. This river is navigable up to Lake Champlain, by means of a dam and lock at St. Ours (14 miles above the mouth) and the Chambly Canal, 12 miles long (32 miles farther up), for vessels drawing 6½ feet. A new canal is proposed from Caughnawauga, about 12 miles above Montreal on Lake St. Louis, to connect with the Chambly Canal, thus admitting of quick water transport from Montreal to Lake Champlain *viâ* St. John's. The Chambly Canal is to be enlarged to the same dimensions as the Welland, and the new canal is to be constructed on the same scale. The possession of the Richelieu canal system would give to the British navy access to Lake Champlain, a fact sufficient to demonstrate its importance.

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RAILWAYS.

The Canadian system of water communication is supplemented by an extensive system of railways, the most important of which have a general direction almost parallel with the general course of the waterways. Stretching across the continent from Halifax to Vancouver, with a total length of about 3,600 miles, is the Canadian Pacific Railroad. This road, in *commercial* aspects one of the greatest in the world, is furthermore of great *strategical* value to Great Britain. If left intact, it could, in conjunction with the Pacific steamers, in the space of 40 days, transfer troops from the banks of the Ganges to the shores of the St. Lawrence; and would enable England speedily to place an Anglo-Indian Army anywhere in Canada. But, unfortunately for us, the portion of the road from Lake Superior to the Pacific runs parallel to our boundary and within easy striking distance of it; while the branch from Montreal to Halifax not only lies on the wrong side of the St. Lawrence for safety but a part actually lies within the borders of the State of Maine. Colonel Strange, writing more than a decade ago, says: "I have not taken note of the wilderness between Lake Superior and the Pacific, as it can scarcely be said to contain a military objective; an army could not subsist in it, and in any case we could not defend it unless the Canadian Pacific Railway is constructed."

Since Colonel Strange wrote the railway has been constructed. It now furnishes in itself an objective in the region referred to; and from the very situation of the road, all the efforts of the British Empire probably could not save it from the destructive forays of cowboys from Montana and North Dakota.

That Colonel Strange is right in saying that the St. Lawrence is open to British gunboats, and to them alone, as long as the fortress of Quebec is kept in a defensive condition cannot be denied. The treaty of 1817 limits the naval force to be maintained by the United States and Great Britain to the following vessels on each side, namely:—

On Lake Ontario, one vessel, not exceeding 100 tons burden, and armed with one 18-pr. cannon;

On the upper lakes, two vessels, not exceeding like burden each, and armed with like force;

On the waters of Lake Champlain, one vessel not exceeding like burden, and armed with like force.

Each nation is also forbidden by the treaty to build vessels of war on the lakes.

It would, therefore, be impossible for the United States to place a fleet of gunboats on the lakes without sending them round (by way of the ocean and the St. Lawrence) past Quebec; for we cannot build gunboats on the lakes in time of peace without such violation

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of the treaty as to furnish a *casus belli*, and after war breaks out the opportunity for unmolested naval construction is gone.

EFFECT OF THE GEOGRAPHICAL CONDITION UPON MILITARY OPERATIONS.

As a means of forming an estimate of the military value of these various conditions of the physical and political geography of Canada, let us suppose that a war has broken out between the United States and Great Britain. The first question for the Americans—"Shall we assume the initiative, or wait in a defensive position the assault of the enemy?"—is quickly answered. As to the Atlantic Gulf and Pacific seaboards, circumstances plainly demand the adoption of the latter course. As to Canada, the natural aggressiveness of the American people, combined with a confidence born of their traditions, will demand the adoption of a vigorous offensive.

Let us consider the matter from the American point as set forth by Colonel Wagner.

In the selection of an object it is of paramount importance so to direct our efforts as to isolate the Canadians as much as possible from Great Britain and to separate the different provinces from each other. Quebec is the most important objective, for its possession by us would prevent the naval or military reinforcement of the British armies or fleets above that point, and history proves that it is the key to the conquest of Canada. Though we should therefore regard Quebec as our ultimate objective we cannot make it our immediate one. The old line of invasion *viâ* Kennebec and Chaudiere rivers, followed by Arnold, difficult to the last degree for his small force, may be regarded as altogether impracticable for the large army that would now be required for the reduction of the strongest place on the Continent. The route *viâ* Richmond and Athabaska would lend a flank to the attacks of the British and expose our communications from Montreal. The only route is the one adopted by Montgomery, the route *viâ* Montreal; and the reduction of that city must be first effected in order to protect the flank of the army marching down the St. Lawrence. Moreover, that river is desirable for the transportation of heavy ordnance, without which the siege of Quebec would be a farce. Finally the control of the river by vessels of war or heavy floating batteries is necessary, in order that the city may be invested . . . otherwise the investing army would be cut in two by the stream. We are, then, at first, neither in a position to reach nor to reduce Quebec.

MONTREAL.

The capture of Montreal is a necessary stepping-stone to the reduction of Quebec. But there are many other reasons why we should choose Montreal as our primary objective. We have already seen that the Canadian canals give entrance to British war vessels into the Great Lakes. The capture of Montreal would cut Canada in two; it would

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give us possession of Beauharnois and Lachine canals, and protect the country above from naval attacks by any vessels except such as might have ascended the St. Lawrence before the surrender of the city; and the ultimate capture of such vessels would be certain. Moreover, it would place us in possession of the metropolis and chief railroad centre of the Dominion, thus causing such embarrassment to the trade of the Canadians as to bring them to a realizing sense of the inconvenience if not the horrors of war. Finally, it would place us in the best possible position for operating in any direction that military circumstances might require.

It seems clear, then, that Montreal should be our first objective, and that we should here assume the initiative promptly and with as large and efficient an army as possible. This army, from the nature of the theatre, should be composed of a large proportion of infantry, with field artillery not exceeding three guns to each thousand men of other arms, and with only enough cavalry for screening and reconnoitring duty. The army should not be encumbered with heavy artillery; for its movements should be made with the utmost celerity, and, once before Montreal, its siege trains could be speedily forwarded by rail and water from Albany. A large force should be detached to seize and occupy Richmond, thus holding an important railroad junction, protecting the right wing of the army before Montreal from attack from Quebec, covering Vermont from invasion, and maintaining communication between the army at Montreal and one in Maine which we will consider later on.

An army operating from Albany as its primary base, with a secondary base at Watertown, should move against Prescott and the Williamsburg canals. A successful passage of the St. Lawrence and the capture of the canals would snap the water communications of the British at an important point; and if the passage were absolutely secured, the army would be in a position to operate against Kingston or to move down the left bank of the river against Montreal. In the latter case, however, the British would have the advantage of interior lines; and the movement against Montreal should not be undertaken unless the army, after masking Kingston with a strong detachment, could still be superior to any force which it might encounter. Otherwise the movement would be an imitation, on the same theatre, of the dismal strategy of Amherst in 1760 and Wilkinson in 1813, the former undeservedly successful and the latter deservedly successful. If the activity of the British military and naval forces on the St. Lawrence should protect Prescott and the canals barring the river, this army could at least defend New York from incursions of the enemy, protect the left flank of the army operating against Montreal, and in case of need be drawn in to the assistance of that force. It would be the part of wisdom to limit the strength of the army in question to the numbers sufficient to ensure the destruction of the canals and the defence of the New York frontier.

Hamilton would be an objective of great importance; mainly as furnishing a base for further operations. In the case of Montreal to designate the object is to name the theatre; but with Hamilton such is not the case. Ontario can be invaded from the west as well as from the east; and an army based on Detroit and Port Huron would have as secure a starting

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point as one invading from Buffalo and Niagara. But the operation would not be so decisive. If in the former case we were in complete naval control of Lake Erie, the theatre would give us the advantage of a re-entering base; but otherwise the enemy, if beaten back, would continually cover his line of retreat, would abandon only such territory as was actually wrested from him, and would draw nearer to his reinforcements with each step in retreat. On the other hand, an army invading from the Niagara frontier would at once break the general line of the enemy and a successful battle would probably mean the reduction of the province. A glance at the map shows that if we were to undertake simultaneous movements from Buffalo and Detroit, the Canadians would have the advantage of interior lines with excellent communications. Instead of invading by double lines we should, then, throw our greatest weight on the side of Buffalo; but the Detroit line should not (as we shall see) be altogether neglected, and under certain circumstances it might even become the most important line of all.

A large garrison of regular troops should be continually kept at Forts Porter and Niagara; and at the first sound of war they should be thrown across the frontier, seizing and holding the International Railroad bridges between Fort Erie and Buffalo and the Roebling, Keefer and Cantilever bridges below the falls of Niagara. Pushing on with the utmost celerity, they could then seize the Welland Canal and blow up its locks. If unable to maintain its position on the canal, this force could then fall back and occupy bridge-heads at the bridges mentioned until the main army should begin its passage. Unless the Ottawa and Georgian Bay Canal were completed and in successful operation the destruction of the Welland Canal would ensure the safety of the upper lakes. Lieut. Schenk, in his valuable essay on "Our Northern Frontier," states that within easy striking distance by rail of the Welland Canal, the Canadians have 9,000 militia with 42 guns, completely armed and equipped; but he fails to note that the mobilization of this force would require some appreciable time. Recognizing the value of the initiative, the slowness at best of the militia assemblement, and the superiority of regular troops, it seems probable that a force of two regiments of regular infantry with a squadron of cavalry and two or three batteries of light artillery would, if acting promptly and with celerity, be amply sufficient for the destruction of the canal.

A victory in the Niagara peninsula would almost certainly put us in possession of Hamilton. If defeated we would fall back, covering our line of retreat, to our base. The enemy, if defeated, would doubtless retreat either to Toronto or London. In the former case he would sacrifice all the territory lying between the lakes; and (unless we have read the history of militia wrongly) he would lose by desertion masses of men from that region. In the latter case, he would give up his communications with the forces farthest east; and a second defeat would probably cause the capture or dispersement of his army. In either case, then, the entire railway system between Detroit and Toronto would fall into our hands; we should have a base at Detroit as well as at Buffalo; new levies or other inferior troops could cross at Detroit and Port Huron

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to occupy the conquered country and guard the communications; and the victorious army, easily supplied and reinforced, could then safely attack in succession Toronto, Trenton, and Kingston, even though the enemy were in naval control of Lake Ontario. The capture of these important points would doubtless be a matter costly in men, material, and above all in time. If, however, the canals near Prescott had been destroyed in the meantime, the defence of these places would be greatly crippled so far as naval assistance is concerned; and in any event they might be masked while the army pushed on to the capture of Ottawa and the reinforcement of our first army at Montreal or Quebec. The army operating from Buffalo should be composed of the regular proportion of the three arms.

The relations between Russia and England might necessitate the retention in India of a great British military force. But national friendships and enmities are essentially fickle; and arrangements with Russia might enable England to send a formidable Anglo-Indian army against us. *At any rate, unless Great Britain were actually at war with the Czar, we should be obliged to provide against a reinforcement of the Canadian armies by troops from India.* A small army composed of volunteers raised in Minnesota and the Dakotas should be assembled at St. Vincent and sent against Winnipeg, which place should be captured and strongly held, the railroads to the east and south being carefully guarded, and the railway west of the city being utterly wrecked for miles. Raiding parties should be sent from various parts of the frontier of Montana, with instructions to blow up bridges and viaducts and tear up the road to the utmost degree in their power. An attempt should be made to destroy the Canadian Pacific Railway in British Columbia; but beyond sending a small force for this purpose, the operations of our armies on the Pacific Coast would, as we have already seen, be necessarily limited to the defensive.

Thus far we have considered things in a rather favourable aspect for the Americans. Let us suppose, however, that the war, while of nature to be a surprise to us, has been premeditated by Great Britain. Her 146 war-vessels suitable for service on the lakes, while probably not all available for duty in American waters, permit her to assemble a large fleet on the St. Lawrence; a force is posted on the Niagara river, covering the Welland Canal, and strongly intrenched; the St. Lawrence canals are strongly guarded; and a large army in an intrenched camp at St. John's bars the way to Montreal; in other words it is impossible for us to cross the St. Lawrence or the Niagara, and the British navy has free access to Lakes Ontario and Erie. The Detroit route now becomes of paramount importance. Vessels taken from our merchant marine on the lakes, regardless of cost, are sunk in the channel of the Detroit River, and the passage of the British fleet is further barred by submarine mines. If the Ottawa and Georgian Bay canals be completed, similar obstructions are placed in St. Clair River. We thus secure a passage into Canada, which passage will be greatly facilitated by the completion of the tunnel of the Detroit River. Our worst strategic line now becomes our only one. On this we must beat the enemy back upon his natural line of retreat, and drive him upon his reinforcements. The war will be long, bloody, costly and bungling—in fact it will be just such a war as we have carried on

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more than once in the past. Our military force must be enormous, because we shall have long lines of communication and they will be everywhere exposed to combined naval and military expeditions—"naval raids," if I may be allowed to coin that term. Still, by sheer dint of superior numbers and resources we should probably be able to reach Ottawa, open new communications *viâ* the Canadian Pacific to Sault Ste. Marie and Winnipeg, and push on to Montreal in spite of the British gunboats controlling the lakes. It would be a case in which "the longest way round would be the shortest way home," because it would be our only way. Even in this case, unless such places as Kingston were masked by very large detachments, their reduction might occupy as much time as the capture of St. John's and Montreal by the first army considered. Our lack of preparation and our want of naval force would place us at a heavy disadvantage.

We will suppose, however, that the canals have been seized as already indicated, and operations carried on as already described. Thus far it may, I think, be safely claimed that the military geography of Canada has favoured the Americans quite as much as it has their adversaries. But in the eastern theatre the geographical balance, so to speak, is heavily against us. Morever, it is important to remember that reinforcements from India can reach the St. Lawrence *viâ* the Pacific Railway in 40 days.

I have dwelt enough on these points. I need scarcely say that this is a mere strategical discussion, not a bit *doctrinaire*, and entirely void of the slightest pretence to practical or party political value at this, or any other given, moment. We must eschew alike metaphysics, and dialectics, and party politics in this hall; and indeed it seems as if they were all three becoming identical—and thus disastrous, as being an attempted combination of incompatible elements.

II. WEST INDIAN ISLES.

Now for the strategic position of the West Indian Isles, so celebrated in the annals of the British Army from the days of Cromwell to the celebrated rush of Nelson for their preservation. Let not our garrisons be hastily removed. These isles are of vital importance, as I wrote a few days ago, quoting Capt. Mahan, to the *Morning Post*.

The importance of these Isles and of the surrounding seas has been recognised by all competent geographers for centuries; they have been the keys of international strategy since the days of the Emperor Charles V.

The Caribbean Sea and the Gulf of Mexico taken together form an inland sea and an archipelago. From the Caribbean, Great Britain, although her rivals had anticipated her in the possession of the largest and richest districts, derived nearly 25 per cent. of her commerce during the strenuous period when the Mediterranean contributed but 2 per cent.

Capt. A. Mahan, in his *Interest of America in Sea Power*, page 277, says: "The Caribbean is pre-eminently the domain of sea power"; and again, page 280, "In the Caribbean, likewise, the existence of numerous

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important ports, and a busy traffic in tropical produce grown within the region itself, do but make more striking the predominance in interest of that one position known comprehensively, but up to the present somewhat indeterminately, as the Isthmus. It is in the political fact that on the Pacific coast are the outposts to the exposed pioneers of European civilisation that is to be found the great significance of the future canal across the Central American isthmus, as well as the importance of the Caribbean Sea, for the latter is inseparably intwined with all international consideration of the Isthmus problem. Wherever situated, whether at Panama or Nicaragua, the fundamental meaning of the canal will be that it advances by thousands of miles the frontiers of European civilisation in general and of the United States in particular; that it knits together the whole system of American States.

AUSTRALIA AND CANADA.

The West Indies cannot be considered apart from Canada and Australia any more than we can consider India apart from South Africa. With the opening of the Panama Canal the Dominion's Pacific seaboard will be brought nearer to her Atlantic seaboard by thousands of miles. The intervening South American Continent, which has now to be doubled to establish sea communication, will be cut off. That is to say, the interest of Canada in the projected waterway is the same as her neighbour's. Nor is this all. Australia will have an alternative route to the mother country nearer than that by way of the Suez Canal, and New Zealand will gain a great deal more. In short, the ocean highway, which will be created by cutting through the Isthmus of Panama, will not only be vital to us in our trade with the Far East, but it will link the Dominion and Australia more closely with ourselves. A war in the Western Hemisphere is not impossible, neither is a war in which it may be of the utmost importance for us to maintain uninterrupted communication between the Pacific and Atlantic. How have we provided for such a contingency? By permitting the United States to construct the Panama Canal as a national undertaking, instead of in partnership with this country; by letting Hawaii slip through our fingers, when the natives were eager for our protection; by giving up without equivalent Greytown and other strategical positions commanding the Isthmus.

I understand fortunately that if the Mother Country proposes to cut the West Indian Islands adrift Canada is prepared to take them over.

PANAMA CANAL.

President Roosevelt is subject to no delusions. His views are clearly expressed as follows:—

"We have necessarily undertaken to police the seas at either end of this great waterway, and, as a result, the United States has a

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peculiar interest in the preservation of order for the peaceful passage of commerce along the coasts and among the islands of the Pacific and the Caribbean Sea.

"We can help the nations in the vicinity of the canal by a wise and generous assistance, so that by-and-by they can stand alone more securely than they now do. If, unhappily, they should decline such help, this would be bad for them and bad for us, and would ultimately probably cause the United States to face humiliation or bloodshed."

III. AUSTRALIA.

Leaving aside our American and West Indian frontiers, in which no very considerable change has taken place in living memory, let us turn to Australasia, Africa, and India. The first is a creation of the reign of Queen Victoria; and a splendid property is this mighty island daughter of ours, and greater she must become. Its far-seeing statesmen bitterly resented the folly which allowed two strong European powers to approach its shores, and they show a strong and clear perception of its strategic position. They are quite convinced that, being on the flank of America, Asia, and Africa, their country's strategic potentialities are immense; and they view the sudden and portentous awakening of far eastern states, not with apprehension, but with a keen interest which will soon assume important developments.

But it is in Africa and in Asia that our frontiers have been so advanced and complicated that they are conterminous with every variety of civilisation, of military organisation or disorganisation, with all the colours and all the creeds of mankind.

RAPID CHANGES IN OUR STRATEGIC SITUATION.

With regard to several very important, indeed vital, considerations, the position of the United Kingdom is altered now as compared with its position at the time of the Accession of Queen Victoria.

In the first place the British Islands were then absolutely an insular power, that is to say they had an absolutely undisputed command of the sea. No other Power had a Navy worthy of the name; no combination of Powers would have dreamed of attacking the British Empire. That is not so now. Fortunately, after much pressure, the Admiralty authorities a few years ago put our naval house in order, and consequently, with regard to the command of the sea, we are again able to "speak with our enemies in the gate"; but other Powers have developed navies quite fit to fight and ready to fight. That is one particular in which our relations with the world at large have changed since the Accession of Victoria.

Another serious consideration is that when Her Majesty came to the Throne we were practically the only colonising Power. No

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other Power thought of expanding into Asia, except Russia. No other Western Power was trying such a thing. France had given it up altogether; it had never entered the head of any Bavarian, Swabian, Styrian, or Austrian; the Brandenburg Royal Family was not then master even of North Germany. *Now* we march with continental peoples in many a portion of the world. The boundaries in black can be clearly traced on the large Navy League map. The boundary of Russia in Asia touches Britain on the Pamirs, is very near Britain at the top of Afghanistan; France touches Britain north of Burmah; Germany in South Africa; and so on. That alters our position strategically to a very considerable extent. Having such powerful military nations as neighbours, instead of being bounded by semi-civilised or barbarous people, is a strategic change of serious import.

Moreover, during our period we have ceased to be able to live on the produce of our islands. In 1837 England and Ireland could feed their people; in 1899 we imported three-fourths of our bread stuffs, I think two-fifths of our meat stuffs, and nearly all our luxuries; and where would we be if for a moment we lost our command of the sea or our reputation as a military Power.

So, having regard merely to the relations of England with other Powers, the strategical geography has changed in Her Majesty's reign in such a fashion as would require hours to describe.

IV. AFRICA 1859 AND NOW.

I have a map of Africa in 1859—what a *terra incognita;* from 5 degrees of Latitude N. to 30 degrees S. is a blank. European powers occupied a mere fringe of that weird Continent:—Ancient Egypt, the coast of the old Roman provinces along the north from Alexandria to the pillars of Hercules, a few trading and fever-stricken settlements along the West Coast, Cape Town and Natal and their environs, were practically all. The vast Sûdan, the Congo Basin, all Nile land, and the great Lake land south of the first Cataract were given over to Mahommedan or Pagan anarchy.

Look at the map now. Observe thriving communities and larger trading cities. See how we touch Abyssinian and French and German territory; follow our numerous explorations and annexations; consider the Zulu and Boer wars, the raids on savagery in Ashanti and Bida and all along the Niger and up to the sources of the Nile; the bridging of the Zambesi and the railway past its magnificent falls, and the road from Mombasa through the forests and highlands of Uganda. Where commercial and exploring adventurers set their feet the British soldier is certain soon to follow—to plant the Union Jack and protect the natives. But let us not deceive ourselves. Germans and Italians, French and British, have almost reached the

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limits of their superiority over the black and brown and yellow races of mankind. Modern armament, modern drill, modern skill, combined with the native hardihood and slimness and physical prowess of the coloured races, may soon restore the balance.

V. ENGLAND'S DEPENDENCIES IN ASIA.

England's dependencies in Asia comprise, besides the Indian peninsula and the adjacent islands, the Straits Settlements and islands, the Malay peninsula and island, Hong Kong and the Keeling islands. The Maldive islands are nominally connected with Ceylon, and the islands of Singapore and Penang with the Straits Settlements, while Burmah is the southern entrance to China. All these possessions are peninsulas and islands, and most of them in the tropics; for unlike Russia, England has not gained large accessions of inland territory, her object being trade and strategic stations rather than colonization. Thus Aden, on the way to India, serves commercially Arabia; at Singapore unites the commerce of the Malay peninsula, Australia, and India; the military-commercial station of Hong Kong guards the British interest of northern and western China. The Englishman in Asia is merchant and dominator, not a settler.

England can enter China through India as well as by the eastern ports. The British gateway to China is Burmah. A railway from Burmah to the navigable waters of the Upper Irrawaddy and Yangtse will place western and southern China and the vast interior under British control. The British possessions adjoin the Chinese Empire on the south-west, as the Russian possessions adjoin on the north. Here then are the two great dominating powers in China, Russia on the north and Great Britain in the central and southern parts. The railway from Mandalay in Upper Burmah to Kunlon ferry on the Salween river is a move in this direction. The route from Bhamo, as the commercial highway from Burmah to western and central China, was long held by the Indian government in high esteem.

NORTH-EAST BURMAH.

Before this hasty rush along the fringes of our Empire takes us to the north-west frontier of India I may be allowed to dwell on one of the most remarkable incidents in the marvellous history of our Empire, I mean the railway linking the north-east of Burmah with the south-west of the Chinese Empire. As it is an engineering feat of rare device, and as a former member of your Corps, Colonel A. G. Begbie, very kindly sent me the maps and plans, I may be excused for mentioning the bridge over the Gokteib Gorge on the railway which runs to Maymyo in the hills of the Shan States and thence to

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Kunlon Ferry on the Mekong. Here was an old trade route long before the days of Marco Polo, but the toils of the travellers and bearers of baggage up and down the steps of the steep sides of the enormous gorge were exhausting to the last degree.

NORTH-WEST INDIA.

We now come to our Indian Empire. From the 19th of October, 1805, till the disastrous retreat of Napoleon from Russia in 1812, his fiercest foe was the United Kingdom of Great Britain and Ireland. England saved herself by her fleet on the 21st of October, and then saved the rest of the world by example. It is extraordinary to see the developments of our frontiers in every part of the world, which, largely through the antipathy of Napoleon and our desire to thwart his action, were so far-reaching, for he did not confine his ideas of conflict merely to Europe.

There is not the slightest doubt that his incursion into Russia was as much based on his desire to get a good line to India as to any antipathy to Russia itself. All through his career, and particularly in the years 1807–8, he had a persistent notion of reviving that Indian and Colonial Empire which he believed the English had filched from France. He could see the advantage he would gain if he could go from Vienna through Turkish and Persian Territory, from Salonika across Asia Minor, into the Valley of the Euphrates and up the Persian Gulf. He knew full well that the possession of India is doubly important in regard to international policy and in regard to the command of the seas.

Napoleon went in 1798 to Egypt simply to get at India, not that he had any particular desire for Egypt, but because he knew, as Alexander the Great knew, that the possession of Egypt commanded the Red Sea. Alexandria, the Levant, and Syria were the keys of Mesopotamia, and from the Euphrates and Tigris to Afghanistan and Lahore was an easy journey for the young Greek hero from Macedonia. If Alexander could get to the Punjab, why should not the Corsican hero reach Delhi in due time ?

So decided was Napoleon about the value of the Levant and of the Sicilian Strait and of the isles of the Mediterranean, and their relation to the Eastern Empire, that he declared in 1801 that he would almost as soon see the British in the Faubourg St. Antoine of Paris as in Malta. He persistently strove to influence Persia against the English ; and no doubt French emissaries abetted the risings of Tippoo Sahib and the Mahratta States (1799—1805) and drilled their troops.

If Napoleon could have won sea command he would have hemmed in the United States from the Mississippi basin, all of which, from New Orleans to near the Canadian frontier, then belonged to France,

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just as at the same time Florida, Texas, Mexico, and Arizona, and the whole Pacific Coast south of Vancouver's Island belonged to Spain. But fearing lest England might annex New Orleans in consequence of the loss of sea power by the French, Napoleon saw it was no use remaining in the Mississippi basin, and he sold it for £3,000,000 to the United States, who have gone on extending their frontiers ever since. He said, "I give you the command of a large portion of the world with that bargain." Such was the situation in the United States of America. If you want to look up the subject of the frontiers of Canada at your leisure—and it is a most interesting study both for strategical and topographical reasons—you should study the selected papers of the Canadian Military Institute, 1893.

Our Indian frontier on the north-west was advanced in a notable degree from the close of that tremendous upheaval the Indian Mutiny till 1897; and indeed the process is still continuing and increasing our responsibilities. It matters little what the topographical character of a frontier may be. The defence of a state is the man of the state—not wealth or mountains, not allies or fortresses—men of brains and muscles and force of character—nothing else constitutes the true defence of nations.

But the limit of the so-called North-West Provinces has long been an anachronism. It was so when Kashmir and the Punjab and Scinde, the limit of the range of Alexander's operations, were practically annexed (1843—1849). The campaigns of Afghanistan (1878—1880) and of Chitral (1895), not to mention that making of a frontier by Durand and the agreement as to the Pamirs, have brought our frontier across the Indus, and we hold all the issues from Central Asia to that river, the Bolan, Gomal, Kuram, the Khyber, Dora, Nuksan, Baroghil, and Darkot passes. Such is our present commanding position on the northern and eastern slopes of the "Roof of the World" and the Hindu Kush and the Paro-pamisus and the thrones of Solomon. Nor can these issues be turned from the south without the aid of sea power in the Persian Gulf; nor from the north-east except through the Mustagh and Karakorum ranges and through Tibet, a very difficult enterprise and never attempted since the days of the Golden Horde of Chingiz and his immediate successors.

Napoleon and his dreams passed away, but a new power, against which that "myriad-minded" man had warned Europe in vain, soon began to bestride the whole north of Asia like a Colossus.

Russia moved not only to the Pacific but towards India. We were told in 1856 that there was no chance of Russia reaching the Oxus for a few hundred years; yet her soldiers were at Khiva and the Jaxartes before 1876! We were told in 1878 that Russia could not reach Merv till 1950; she was in Merv in 1884.

It appears that politicians have decided that any violation of Afghan territory will be a *casus belli*, and strategic speeches on the

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dangers from Russia have made this a burning question in spite of Japanese victories, and it has been suggested that the Japanese alliance will save India for our Empire! I cannot take any political or strategic side before this audience. The facts are simple. It is obvious that, if Russia could maintain 400,000 men in Manchuria by one poor line of railway, it can maintain 400,000 men on the frontier from the Jaxartes to Persia by the aid of two good lines of railway. Termez, on the Oxus, is within four days' short marches of Balkh, and from Kushk Post to Herat is not much more; yet these places are rail heads, and men like Alexander, Tamerlane, Baber, and Roberts declare that these routes are the roads to Delhi.

Look at the map—it is perfectly clear—and geography is the handmaid of strategy, or perhaps its mother.

History supplies another guide, and I will conclude this long lecture by stating how India has been invaded with some twenty-five distinct operations directed against its enormous wealth and its disunited and ill-prepared communities.

ALEXANDER THE GREAT.

We are not acquainted with the real reasons which induced Alexander to pass through Káfiristán on his way from Bálkh to India; but, of course, in selecting this route he had to cross a mass of mountain ranges, to pass through terrible gorges, and to get over mountain streams and ravines without number, whilst there lay open to him the very practicable route along the Kábul river. However this may be, the circumstance is important in proving that regular troops can make their way from Bálkh to India, not only by way of the Bactrian-Kábul and the Khyber routes, but also by tracks within the very heart of the Hindu-Kush mountain range. It is very likely that Alexander wished to reach India without encountering races distinguished for their wild and warlike propensities.

CHINGIZ KHÁN OR ZENGHIS KHÁN.

The Mongol army went into winter quarters in the mountain province of Buiya-Katavar, near the sources of the Indus, whence, in the spring of 1223 A.D., Chingiz Khán moved forward with the intention of marching through Tibet into Mongolia. Being checked in his advance in this direction by the natural difficulties of the country, he ordered his army to march toward Peshawar; and, in all probability, the route he then took was by the valley of the Kábul river. In the autumn of the year 1223 A.D., Chingiz Khán passed through Bálkh. His Indian campaign may be said to have finished here, for, after various wanderings in Central Asia, he returned, in the autumn or winter of 1224 A.D., to his own country, Mongolia.

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The campaigns of Chingiz Khán and of his generals present a striking picture of rapid raids carried out in various directions. They were, indeed, a series of tempests, of which history gives no other examples. The Indian campaigns of Chingiz Khán are especially remarkable for the rapidity with which they were undertaken. Thus, setting out from Mongolia in the autumn of the year 1218 A.D., by the end of the year 1221 A.D. Chingiz Khán stood, as a conqueror, on the banks of the Indus. This means that, in a little over three years' time, his main body marched not less than 3,333 miles, whilst, during the same time, the detachments sent out under the sons of generals of Chingiz Khán traversed more than 5,333 miles.

The campaigns of Chingiz Khán also teach us how much may be done with cavalry mounted on small horses, taught—as Mongol horses are taught—to endure long and rapid marches, with only under-foot pasturage for food until the summer heat enables them to be turned out to graze on the rich grazing grounds of a mountainous country.

TIMUR OR TAMERLANE.

On the 13th (25th) December, 1398 A.D., Timur was joined by his left wing at the bridge of Fulkubli, close to the town of Samáne. This wing, which had marched from Kábul, crossed the Indus at Attock, and thence advanced victoriously through the Punjáb, capturing many towns and forts as it passed along. On the same date Timur's main body also came up. He then crossed the Jumna by the Fulkubli bridge, and the next day appeared before Delhi, the capital of India.

By the 4th (16th) January, 1399 A.D., Timur's Imperial Standard was waving on the walls of Delhi. The capture of Delhi and the destruction of Sultan Mahmúd's army placed in Timur's hands a considerable portion of the country. Two days were spent in the pillage of Delhi; and on the 18th (30th) January Timur marched down the Jumna and appeared before Muttra, which fell after an assault on the 26th January (7th February). From Muttra Timur directed his army towards Toglokpur in the Ganges valley. From this point he marched in a north-easterly direction. On the 8th (20th) February he recrossed the Jumna; on the 21st March (2nd April) he recrossed the Chenáb, and on the 24th idem (5th April) he reached Hebgán on the frontier of Kashmir. On the 25th March (7th April) Timur quitted his army and started for his own capital, Sámarkand. Within two days he had recrossed the Indus, and on the third day he had arrived at Bannu. On the 2nd (14th April) he rode to Nagaz or Nargazi—the modern Kuram—where he halted for 24 hours in order to superintend the fortifying of this place, to which he attached great importance in a strategical sense.

From Nargazi he rode on to Kábul, and thence he crossed by the Shibr (or Shibrtan) pass of the Hindu-Kush to the town of Kesh (or

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Shahr-i-Sabz), his own birthplace. From Kesh Timur reached his capital (Sámarkand). Thus ended his famous campaign against India.

NÁDIR SHÁH.

On the 13th (25th) April, 1740, Nádir Sháh's standard was once more unfurled on the walls of Kandahár, whence he had started on his campaign against India, the interval between his departure from, and his return to, this place being two years and seven days. During this period his forces had traversed the following distances :—

	Miles.
From Kandahár to Kabul	316
„ Kabul to Pesháwur	195
„ Pesháwur to Delhi	567
„ Delhi to Kabul, or a little north of that city ...	800
„ Kabul to Dera-Ismail-Khán	335
„ Dera-Ismail-Khán to Dera-Gházi-Khán... ...	135
„ Dera-Gházi-Khán to Larkhána	267
„ Larkhána to Umarkoti	140
„ Umarkoti back to Larkhána	140
„ Larkhána to Shikárpur	67
„ Shirkápur to Kandahár	356
Total	3,318

During this period (about two years) Nádir Sháh's army, either on the line of march or in battle array, hampered with a huge transport train, and with a considerable complement of artillery, had passed through difficult gorges, ascended lofty mountains, traversed almost trackless deserts, and effected the passage of wide rivers. The return route through the Panjáb was, moreover, accomplished during a season of fierce heat.

On the 18th (30th) April it marched out of Kandahár, and on the 15th (27th) May arrived at Herat, after traversing a distance of 380 miles in 28 days.

If, then, we take Ispahán as the starting point, we shall see that Nádir Sháh's forces had traversed 4,667 miles in about three and a-half years.

This feat was accomplished by large masses of men of strangely diverse nationalities, welded together in one compact whole by this remarkable Turkumán, who had, in a comparatively short space of time, substituted for a mere rabble, devoid of all military organisation and discipline and even lacking in martial ardour, a highly effective military force.

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VI. CONCLUSION.

Whether the Empire, the frontiers of which have been our theme, be a magnificent growth or (as some say) a malignant one, our military men have not been the motive power of either its expansion or retention, nor have they provoked wars or been agents of strife. The expansion has been principally, and for 200 years altogether, a matter of commercial and naval enterprise. Why were India, North America, the Cape, Mauritius, and the West Indies acquired and kept at the cost of so much blood? For wealth, for trading purposes, and for these purposes only. "He who possesses power over the ocean has the trade of the world," said Raleigh. "The wealth of both the Indies is incidental to command of the seas," said Bacon. During the great wars, "our shops were bursting with opulence into our streets," said Burke.

What were the objects of the East India Company, the Hudson's Bay Company, and other great Chartered companies? Dividends. The merchant adventurers sought in all their travels for the "utmost wealth of Ormus and of Ind." Lust of power, love of conquest, religion, or civilisation had nothing whatever to do with their enterprises. Singapore, Ceylon, Hong Kong, Newfoundland, Demerara, were acquired and developed for trade purposes and for these only. The soldiers seized and preserved them. Officers and privates have often been even more ruthlessly exploited than the natives themselves; but they did their duty, and the results were all these acquisitions, and yet they got all the hard knocks and much of the abuse in cases of failures generally due to political incompetence. But the people who did most work certainly got least in return. The dividends were in inverse proportion to the pay of the troops, yet their labours are writ large on that map of Empire on your walls.

I have thus shortly traced some of the most significant questions of present importance and of historic interest relating to the greatest of all Empires past and present. Wherever in modern times the British soldiers have marched, wheresoever a serious crisis of advance or retreat, of triumph or of isolation, has marked their chequered careers, by many an ancient city, by many a foreign strand, in the waterless desert or amidst everlasting snows, or in the more deadly luxuriance of tropical swamps and forests, the aid of your Corps has been ever welcome, and helpful—*Ubique, per mare et terras.*

For me to be allowed to lecture to such an audience is not only a great privilege but also a distinguished honour.

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THE ATTACK OF ENTRENCHED POSITIONS.

By Capt. J. E. E. Craster, R.E.

"It will seldom be advisable to endeavour to come to close quarters and break through the enemy's defence at every point. The better plan is to outflank at least one of the enemy's wings; to seize localities from which a searching and sustained fire may be developed against a weak point of the position; to strike at that point heavily, unexpectedly, and in the greatest strength possible; and elsewhere to establish bodies of infantry so close to the enemy's line as to hold him to his ground and prevent him from either changing front or from reinforcing the troops defending the point of attack."*

The last sentence of this paragraph describes an operation which must come first in chronological order. Before either turning the enemy's flank, or assaulting a weak spot in his defences, it is necessary to establish infantry close enough to the whole of his front to hold him to his defences. No hint is given as to how close this must be; but it seems certain that the retaining force should be everywhere within effective, and at some points within decisive, range, or even within assaulting distance of the enemy's position, during the whole time that the turning movement is taking place—a matter of several days. It is impossible for the retaining force to remain so near the enemy's trenches, day after day, and night after night, unless they themselves are protected by entrenchments.

The attacking force must, in the first instance, advance against the enemy's position in widely extended lines, for this is the only formation in which troops can manœuvre under heavy fire. They should be supported by artillery and also by long range infantry fire, if the latter can be brought to bear. The advancing troops should not waste time in firing, because they cannot hope to establish a superiority of fire over the defence. A widely extended line exposed in the open cannot be expected to subdue the fire of an entrenched force; the object of the retaining force should be to get as close to the enemy as possible, and then establish themselves, that is entrench. On the other hand it must be remembered that the first line is always much exposed to local counter-attacks, and that in order to resist these it should be as strong as possible. It is necessary therefore to satisfy two conflicting conditions; if the first line is

* *Combined Training*, 1905.

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very strong it will suffer unnecessary losses, if it is too weak it will give way before a counter-attack.

In open ground a single row of trenches will not be sufficient. The first line of the retaining troops should have a second, and perhaps a third, line entrenched behind it, from which it can be supported if necessary, and on which it can rally if driven back. The men in the first line, who must dig lying down, will only be able to excavate a number of isolated holes; possibly the second and third lines will not accomplish much more. These isolated holes must be connected and converted into a trench on the first opportunity, usually after nightfall.

It may, perhaps, be thought that the retaining force should not attempt to take up its position till after dark. Though it might thus escape with fewer casualties, it could not establish itself with so much certainty, it would have less time to devote to its defences, and it might find that owing to faulty siting its trenches were untenable in daylight. In order, however, to render the period of exposure as short as possible, the troops should not move forward till an hour or two before sunset.

It is extremely desirable that the trenches should be connected by covered approaches, thus rendering it possible to relieve the men in the first trench during the daytime, and, what is of more importance, to reinforce them or withdraw them unobserved. At the battle of Nanshan the Russians had constructed three tiers of trenches, but had not connected them. Nearly all their casualties occurred when they were attempting first to reinforce and subsequently to withdraw the men in the front trenches. The Russians believe that, if their trenches had been connected, the Japanese would have been repulsed.

The form of trench adopted for the various lines must depend on the time available, the nature of the soil, and the proximity of the enemy. But as the first trench will be exposed to very oblique, if not enfilade, fire, it should be traversed, recessed, and furnished with head cover. If time and materials are available, a certain amount of overhead cover should be provided in each trench.

It will not be easy to prevent the communication trenches from being enfiladed. The old form of zigzag approach, that was always lined on a point beyond the enemy's flank, is impossible when the flanks are miles apart. The adoption of a wavy trace would probably render the trench fairly safe. The great object to be attained in the communication trenches is cover from view, so that all movements of troops can be carried out unobserved. Good cover from fire is desirable, but not essential.

By the time the retaining force of infantry have firmly established themselves, the point on which the assault is to be delivered will have been selected. Other things being equal, a salient is the weakest

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point, because a cross fire can be brought to bear upon it. As regards other conditions a position on or below the front crest of a fairly steep hill, with a narrow valley in front, seems to offer the best chances of success. It should then be possible to support the assault with fire from two or three tiers of trenches, cut in the opposite side of the valley. The enemy's reinforcements will be much exposed in moving forward over the crest; and as the ground falls away from in front of their trenches, the defenders must expose themselves a good deal before they can fire down on the assaulting force.

The greatest care must be taken that the preliminary arrangements shall not indicate the point selected for assault. It would be foolish, for instance, to construct the trenches so that they all faced the threatened point. On the other hand, it should be possible, during the night before the assault, to align the loopholes of the trenches so that the fire of the retaining force should be made to converge towards it; this could be done without the enemy detecting the fact. Unless some precaution of this sort is taken the troops will fire at the nearest target, that is straight to their front, instead of trying to enfilade a distant point of the enemy's position. Perhaps a better method would be to make two loopholes to each recess, one facing straight to the front for use in case of a counter-attack, and one in the angle of the recess facing the point of assault.

The question of how the assault should be delivered is almost outside the scope of this article. It should be carried out over as broad a front as the artillery can sweep, and the assaulting force should be given as great depth as possible. Line after line should be sent forward until the enemy's position has been effectually pierced and the assaulting troops are too firmly established to be driven out by a counter-attack. The more rapidly the assault is carried out, the more likely is it to succeed.

The whole duty of the artillery during the attack is to support the infantry. As a rule the guns should be silent unless the infantry are on the move or lying exposed in the open. During the preliminary phase, therefore, the guns must keep down the enemy's fire as much as possible, so as to allow the retaining force to establish itself with comparatively little loss. When once the infantry are properly entrenched, the artillery should reserve its ammunition until the assault. The bombardment of empty, or half empty, trenches is a harmful proceeding, as it inflicts no appreciable loss on the enemy, and merely incites him to improve his defences till by the time the assault is ready they are as shrapnel-proof as human ingenuity can make them.

The greatest care must be taken in selecting the artillery positions to support the assault; every gun that can be brought to bear must be employed. The object to be attained is to bring an enfilade, or at least a very oblique, shrapnel fire to bear on every part of the

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defenders' position from which he can molest the assaulting force. To do this it may often be desirable to push single guns quite close up to the enemy's lines. These guns could never fire straight to the front; but should be placed in sunken splinter-proof shelters, and should fire through a small embrasure cut towards the point of the enemy's position which they are required to enfilade. The effect that one modern quick-firing gun could produce under such conditions should amply repay the time and trouble involved in making the shelter, and should compensate for the possible loss or destruction of the gun. When the gun was firing rapidly the ventilation of the splinter-proof would be very difficult, and this point should not be overlooked.

During the preliminary operations every effort should be made to locate the enemy's artillery, his rallying position, and his field redoubts, if he has constructed any. The only means of doing this will be by the use of balloons, kites, and (before long) flying machines. If possible, howitzer batteries should be established within range of any defences that lie in rear of the point of assault. As soon as the assault has been delivered, fire should be concentrated on these works.

In conclusion it must be admitted that the system of attack which has been described will involve an appalling amount of spade work, especially in open country. In the light of recent battles, however, it seems to be the only feasible method of carrying out the attack as advocated in the *Manual of Combined Training*. If this is correct, then an entrenching tool must form part of every soldier's equipment, and he must be carefully taught when, where, and how to dig.

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MULTI-CYLINDER PETROL ENGINES.

By 'CRANKSHAFT.'

A CONSIDERABLE amount of discussion and correspondence has taken place lately in the Press as to what is the best number of cylinders to employ in petrol engines for use in motor cars and launches; and there is a possibility of a special race being organized to elucidate this point. It is generally agreed that either a four or a six-cylinder engine is the most suitable; but in a few cases eight cylinders have been used; and it must be remembered that a two-cylinder engine (of special design) won the Tourist Trophy Race.

Advocates of the six-cylinder engine maintain that it is much smoother running, owing to the more even torque produced and its excellent balance; and that the strains set up in the various parts (and consequently the amount of wear that takes place) are much smaller for the same power. Whereas those in favour of the four-cylinder engine say that the gain in smoothness of running by the adoption of six cylinders is not sufficient compensation for the extra weight, space, and complication entailed; that the four-cylinder engine gives very fair crank effort and balance; and that it has been found very satisfactory in general use.

The question of crank effort and balance is susceptible of mathematical calculation, and will be further dealt with hereafter. As regards the question of weight, since four working strokes in one engine correspond to six in the other, it follows that the power of each in the latter case is smaller, the strains set up are smaller, and consequently the various parts can be made lighter. Also, owing to the torque in the six-cylinder engine being more even than that in the four-cylinder one, a lighter flywheel can be employed; but on the other hand there is the weight of the two extra cylinders, etc. As regards complication, figures have been published in one of the newspapers, showing that a well-known make of four-cylinder engine consists of 776 parts; and that the increase on a similar powered six-cylinder is less than one-quarter. Hence it appears that the six-cylinder engine is both heavier and more complicated than the four-cylinder of the same power, but that the increase is by no means proportional to the number of cylinders.

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CRANK EFFORT.

The crank effort (*i.e.* the moment exerted by the connecting rod to turn the crank) depends principally on the magnitude of the force transmitted by the connecting rod. Apart from the angularity of the connecting rod, this force is due to two main factors:—(*a*) the pressure in the cylinder, owing to the firing of the explosive charge or otherwise, which can be ascertained by means of the manograph or indicator; (*b*) the force required to overcome the inertia of the moving parts. At the beginning of a stroke the piston is at rest, and considerable force must be used to start and accelerate it; as regards useful work, this force is negative, and must be deducted. After the crank has turned through nearly 90°, the piston tends to go on moving, but has to be brought to rest by the end of the stroke; consequently a positive force is exerted, and must be added to that due to the firing of the explosive charge. These forces can be calculated accurately when the weight of the reciprocating parts and speed of the engine are known.

In the ordinary petrol engine the Otto cycle is employed, giving one working stroke or impulse per cylinder in two revolutions. *Fig.* I. gives a crank effort diagram for a single-cylinder engine. The turning moment is shown in inch-pounds: it rises to a maximum of about 3,200 in the working stroke; during the exhaust and admission strokes, it is alternately negative and positive; and during the compression stroke, it is negative all through: hence a heavy flywheel is required to carry the engine round between the working strokes. This diagram has been calculated for a cylinder of 4″ bore and stroke, giving about 5 b.h.p. at 1,000 revolutions per minute: the indicator diagram gave a mean effective pressure of 84 lbs. per sq. in.

In a two-cylinder engine the cylinders and cranks may be arranged in various ways. If the cylinders are placed side by side, the cranks should be in line, *i.e.* at 360°; this will give an impulse every revolution; and the torque produced will be regular, though varying between wide limits and at times negative: but if the cranks are set at 180°, two impulses will occur in one revolution and none in the next, which is not a satisfactory arrangement. If the cylinders are opposed to one another on opposite sides of the crank shaft, the cranks should be set at 180°, in order to get an impulse each revolution.

In a three-cylinder engine the cranks should be set at 240° to each other: this will give three impulses in two revolutions, evenly spaced: the turning moment is regular, but a considerable amount of negative work has still to be done.

Fig. II. gives the torque diagram for a four-cylinder engine of about 20 h.p. It is obtained by combining at proper intervals four diagrams the same as *Fig.* I. The cranks are set at 180°, and four impulses

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TORQUE DIAGRAMS.

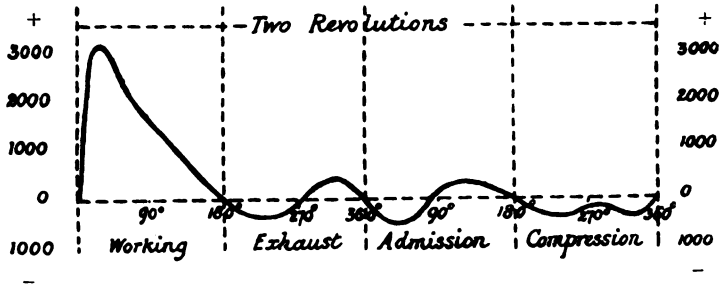

Fig. I. 5 h.p. Single-Cylinder Engine.

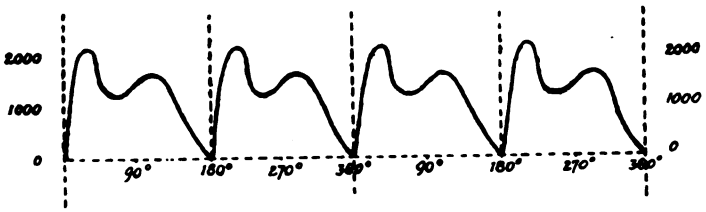

Fig. II. 20 h.p. Four-Cylinder Engine.

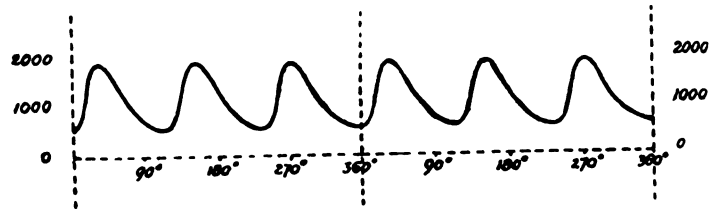

Fig. III. 20 h.p. Six-Cylinder Engine.

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occur in two revolutions. It will be observed that the crank effort is never negative, but that at the end of each stroke it drops to zero at the dead centres. After the crank has turned through nearly 90°, the crank effort increases again ; this is due to the inertia of the piston now acting positively and assisting the motion of the crank.

Fig. III. gives the torque diagram for a six-cylinder engine of the same power as that shown in *Fig.* II. The cranks are set at 120°, and six impulses occur in two revolutions. It will be observed that the turning moment is always positive and never drops to zero (*i.e.* the mechanical imperfection of "dead centres" is obviated) : it varies between about 600 and 2,000 inch-pounds, whereas in the four-cylinder engine the limits were 0 and 2,250. The average turning moment during the cycle of operations is 1,210 inch-pounds in each case.

BALANCING.*

A perfectly balanced engine is one in which the relative movements of its parts have no tendency to make it vibrate as a whole : *i.e.* the reactions of the forces required for the acceleration of the moving parts neutralize each other in every phase of the motion, so that no resultant reaction is felt by the bedplate of the machine.

There are two sets of forces acting on the crank shaft which have to be balanced :—(1) The centrifugal forces due to the rotating parts, such as the cranks and crank pins ; (2) the forces due to the reciprocating parts, such as the piston. The connecting rod has a motion partly rotating and partly reciprocating. For purposes of calculation it is usual to treat it as though one-half its weight was concentrated at the crank pin and rotating with it, and the other half as concentrated at the gudgeon pin and reciprocating with the piston. This is not absolutely correct, but the results thus arrived at are sufficiently accurate for all practical purposes.

The method of balancing the rotating parts consists in the addition of balance weights of suitable dimensions, so placed that the centrifugal forces set up by them are equal and opposite to those produced by the cranks, etc. ; and however complicated the crank shaft may be, or whatever the number of cylinders, the centrifugal forces produced can be completely balanced by the addition of suitable balance weights.

The case of the reciprocating forces is much more complicated, and it may be stated at once that it is impossible to balance a weight that is reciprocating by one that is rotating : hence, to secure perfect balance in an engine, it is necessary to have more than one cylinder, and to arrange the reciprocating parts in such a way that they balance

* For an exhaustive treatment of this subject consult Prof. Dalby's *Balancing of Engines*, 1902.

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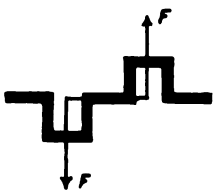
each other. If the connecting rod was infinitely long, the motion of the reciprocating mass would be simple harmonic : the acceleration of the mass would be always directed towards the middle of its path, and would be proportional to its distance from the middle of its path. As however the connecting rod is not infinitely long, and consequently the acçeleration of the reciprocating mass is not the same on each side of the centre of its path (being greater at the end remote from the crank), the method of balancing the reciprocating parts is subdivided into :—(1) primary balancing, working on the assumption that the connecting rod is of infinite length, (2) secondary balancing, which takes account of the definite length of the connecting rod.

Consider now the case of a single-cylinder vertical engine. If no balance weights are added, the reciprocating parts will produce longitudinal forces acting vertically, and a vertical hammering action will be caused. Suppose then that rotating balance weights are added, of such a size and so placed that the centrifugal forces caused by them are equal to the longitudinal forces exactly at the end of the stroke : the result will be that a vertical hammering action is converted into a horizontal one, as the horizontal forces produced by the balance weights themselves will now be unbalanced. So a compromise must be effected, and only a portion (generally one-half) of the reciprocating mass balanced : this will convert a large vertical vibration into smaller ones both vertical and horizontal.

In a two-cylinder engine where the cranks are placed at 360°, the case is exactly the same as that of the single-cylinder engine, except that the reciprocating masses are greater. This applies equally to the type of engine with the cylinders side by side and to that in which they are opposed on opposite sides of the crank shaft. But if the cranks are placed at 180°, the pistons are moving in opposite directions in the two cylinders : consequently the reciprocating forces largely neutralize each other, and a good primary balance is obtained.



A couple is however produced by the longitudinal forces in the two cylinders, which tends to rock the engine about a transverse axis. As regards secondary balancing also, when the cylinders are side by side as in a vertical engine, the result is not satisfactory because the motions of the two pistons are not exactly the same. *Fig.* IV. has has been drawn to illustrate this point : it has been calculated for a two-cylinder vertical motor, the bore and stroke being 4″, running at

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ACCELERATION DIAGRAMS.

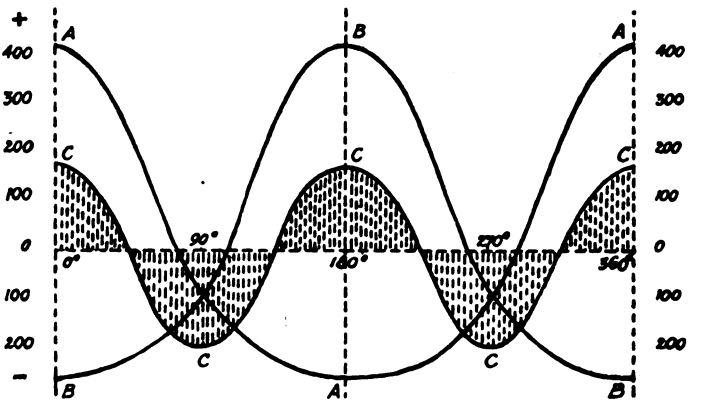

Fig. IV. Two-Cylinder Engine.

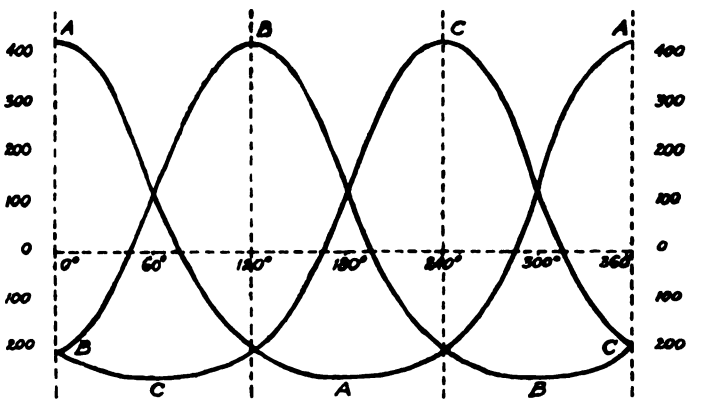

Fig. V. Three-Cylinder Engine.

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1,000 revolutions per minute, the weight of the reciprocating parts in each cylinder being 6 lbs., and the connecting rod being four times the length of the crank. The line AA shows the forces due to the reciprocating parts in one cylinder, and the line BB those in the second cylinder, in relation to the angle turned through by the crank. The line CC, which is drawn by compounding the other two lines (and the shaded portion of the diagram) shows how an up and down thrust results, with a period twice that of the engine.

In a four-cylinder engine with cranks set at 180°, the couple produced by the longitudinal forces in one pair of cylinders will balance that produced in the other pair of cylinders, and there will be no tendency for the engine to rock. But otherwise the case is the same as that of the two-cylinder engine, there being a good primary balance and indifferent secondary balance.

In a three-cylinder engine the cranks should be set at 120° to each other: the longitudinal forces in the three cylinders will then balance one another, and a good primary and secondary balance will be obtained. In *Fig.* V. the lines AA, BB and CC represent the longitudinal forces in each cylinder as before; and it will be found that the sum of these at any point is zero. But, as in the case of the two-cylinder engine, a couple is produced which tends to rock the engine about a transverse axis. By employing six cylinders the rocking couple in one half of the engine can be arranged to balance that in the other half of the engine, and so a completely balanced engine can be obtained.

SUMMARY.

A single-cylinder engine cannot be correctly balanced, and gives a very uneven turning moment.

The best form of two-cylinder engine is that in which the cylinders are opposed and cranks set at 180°.

The three-cylinder engine is well balanced, but the turning moment varies largely.

The four-cylinder engine is well balanced, and gives a satisfactory turning moment.

The six-cylinder engine gives much the best results both as regards balancing and turning moment.

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NOTES ON RAILWAY CONTROL IN WAR.

By 'R. Esso.'

To one who does not concern himself with such matters I suppose a Railway is a thing which runs itself. There are time-tables and ticket-offices and places where goods are collected and loaded up, and everything seems so regulated and organized that there is apparently no particular reason why it should not carry on just as much while war is in progress (so long as it is uninterrupted) as under any other circumstances. It is plain enough that, if engines and carriages and wagons are destroyed or taken away by the enemy, there will be so many fewer to make up trains; and that, if the line is blown up or bridges are smashed, something must be done to join up again before the trains can be got through; and, again, telegraphs have something to do with the working. Indeed, it is clear that means must be provided to secure the restoration of the tangible entity called the Railway System during war; and, of course, there must be men, possibly men to replace employés who have decamped or joined the enemy, or have been removed, or even killed. Then, what about the directing body—the management? In peace the managing body, the directors, heads of departments being their executive, decide all questions of policy, settle what facilities are to be offered to customers, and broadly speaking decide how "Transportation" is to be manufactured and sold.

In war the conditions are a good deal changed. The working plan of the system is determined by the general plan of campaign; the lines have to convey troops as required by the Commander-in-Chief, to furnish their supplies from the Base, to bring them to the theatre of war, and probably to move them about in it.

But, in order that this may be done to the best advantage—a civil organization cannot be expected to be familiar with military requirements, procedure, and terminology—a "rapport" must be established between the scheme of operations and the working of the railways. Programmes and Working Instructions cannot be drawn out, except perhaps for the initial stages—the mobilization—as they can in peace-time, and the preparation of such programmes is normally an elaborate process. When the stage arrives at which the progress of events cannot be forecast there will be an insistent need for some organization separate from the *civil* or *working* staff to co-ordinate

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railway work and military operations. It is essential that there shall be no hitch about carrying out movements when required, and that special requirements be *foreseen* and provided against.

Again, as mentioned above, the normal organization of a railway does not lend itself to rapid changes of plan. Distribution of rolling stock and engines has to be arranged some time in advance; particular stations are laid out for the principal loading and unloading places; running of empty stock involved by reason of the upset of the normal balance means loss of power—a serious consideration when there is a press of traffic. In South Africa, to quote an illustration, the arrangement of minor moves from unequipped stations presented such difficulties that, for Cape Colony at least, it was found worth while to compile a little book called "Entraining Facilities," which contained particulars of all railway stations and sidings, and to issue it to the principal officers in command of Columns and of Posts on the Line of Communication.

There must be some department which can look ahead and forecast with some degree of accuracy what services will require performing, and also say at any moment what the line is capable of doing, so that more may not be counted on; but the Commander-in-Chief must be kept informed, so that he may be able to decide how at any moment the railways can best be utilised. It may seem quite easy, but it may be a hard problem to keep the supply traffic running so as to ensure a sufficient output from the communications and at the same time undertake troop moves upon whose successful execution large combinations depend.

In fact, there must be a Military Controlling Staff, and an efficient and experienced one. The necessity for such a staff has been shown time and again. Its absence was all of a piece with the "ordre, contreordre, désordre" on the French side in the Franco-German war; and even in South Africa, up to the stage when it became fully recognised that there must be a complete chain of control of the railways, great difficulty was experienced in attaining the best results. It is not sufficient to intimate to the railway management what is required to be done at any moment. Apart from the fact that different orders given in different places may clash, military orders must be translated into their equivalent in movements on the lines, and must take into account both the existing situation and the probable future course of events. Again, it is inexpedient that plans of operations should be communicated direct to a civilian body—one might as well publish them in the newspapers!

We arrive then at the inference that a military body is required, independent of the operating force of the army and associated with the railways, with whose general system of operation they are familiar, to act as a controlling agency—in fact to form a buffer between the railway and the army.

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The regulations laid down in various countries for the working of railways in war agree as to the essential principle that there should be a close association of the Military and Technical element in this body; that, in fact, the actual working should be under the supervision of certain "committees"—one calls them so for want of a more apt term—in each of which one constituent should be Military and correspond with the army, while the other should be of the railway Technical staff and give all necessary instructions to the railway officials for the carrying out of the measures decided on in conference.

Evidently it is desirable that these military officers should be conversant with railway working and management (more particularly with the system under operation), for they are liable to be called upon at short notice to say what can be done under all sorts of contingencies towards complying with unusual but urgent requirements.

In fact, Railway Staff Officers, as they were called in the South African War—in another war they may perhaps be called something else—require a special training. But the time to get that training cannot without risk be left till war breaks out, particularly when one remembers that the South African system of lines was comparatively simple. It is not necessary to enumerate the duties a Railway Staff Officer has to carry out; suffice it to say that they are sufficiently plentiful, arduous, and as a rule thankless.

The course of the campaign will necessarily greatly affect the functions which the railways have to fulfil. The line controlled, in any particular instance, may be a Line of Communications pure and simple, possibly altogether outside the theatre of war and practically secure from attack, simply acting as a conveying agency between the collecting area and the base of the Field Army; or it may be a communication line not altogether secure from raid, but operating outside the actual theatre and not having to carry out operation moves. It may, again, be in the theatre of war, and required to carry out at short notice strategic or operation moves, and subject to sudden variations of the lines of supply, that is where there is more than one route from the base or bases. Which case it is entirely modifies the manner in which control is exercised, but not the principle of organization. On the Siberian Railway during the late war part of the line was directed from the Ministry of Communications, part from Army Headquarters at the front, and in some respects the divisions of the system overlapped.

Whether the line is worked by a friendly personnel or whether, having been captured, it is worked by an imported staff, is immaterial so far as the control of its operation is concerned. In both cases the railway officials in arranging transport are intended to have direct dealings with the intermediary staff and not with the troops and departments. Experience has shown the necessity for an organization

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homologous (excuse the word, it savours of Euclid or of French railway rates!) to the pre-existing technical departments and principally to the traffic department, with which naturally the transport of troops and munitions is mainly concerned.

The lines of communication of an army are an agency for supplying the fighting force with men and material as required, and for keeping the army free from encumbrance by removing personnel such as prisoners and sick and, generally speaking, all material not required with the fighting force. It is evident that the line of communication acts as an administrative agency and must in all things conform to the needs of the operating army. The railways, then, must be primarily directed from Army Headquarters, where the Director of Railways will receive his orders from the Commander-in-Chief; and the chain of organization will be completed by the representatives of his department in each railway district being attached to the staff of the Officers Commanding in those districts, and being directly over the Railway Staff Officers at stations or in control of sections of line.

The functions of the Director of Railways are of several different categories. They fall under three principal heads:—(1) Reconstruction; (2) Working, where lines are taken over or working staff has to be supplemented; (3) Control proper, together with the administration of the troops and employés required in connection therewith. The rapid reconstruction and efficient working of the lines are much dependent on the harmonization of military and working requirements; hence the controlling staff must be in close touch with the officers supervising reconstruction and working (whether the latter is undertaken by the Director of Railways or whether the normal civil employés are retained).

The officer associated with any particular system, having general control of the traffic, is concerned to a great extent with civil traffic. It is obvious that measures must be taken to ensure the advantageous utilization of such carrying capacity as is available. We may take it for granted that, after military needs are fulfilled, there will not be an over-large balance for the civil population—assuming of course that the country depends a good deal on the railways for supplies, as most countries do nowadays. There is likely to be some sort of Permit system, and the officers who issue permits will need to be acquainted through some organization with the needs of the districts to which they are attached; and must be able to ensure that supplies intended for the civil population do not fall into the hands of the enemy. Of course if the enemy gets the chance to hold up trains that is another story. The problem of Civil Supply control is in fact a large one, too large for more than a passing mention; it must suffice to remark that the issue of permits needs to be done in communication with the staff controlling the general working of the railways, so that military and

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civil demands on the railway output shall be accurately and equitably adjusted to one another and with due regard to political exigencies.

It is difficult to disentangle altogether the question of Control from that of Working. The Director of Railways in many possible cases is likely to be concerned with both, so that I would now turn to another side of the subject. The R.E. Library has recently acquired a book called *The Strategy of Great Railroads*. The title sounds a likely one, as possibly dealing with the great lines which have a military importance. As a matter of fact it has about as much to do with the military use of railways as Ruskin's *Notes on the Construction of Sheepfolds* has to do with farming, but it supplies some material for thought for all that. The book consists mainly of a study, cast in the form of a series of magazine articles, of the way in which the great systems (or rather combinations) of lines in the United States have been built up with a view to strengthening their position in different regions; the analogy is perhaps more like the way in which one nation prepares its forces against another in peace and arms its Ports and coaling Stations against the day of war.

There have been combats incidental to this strategy, not altogether diplomatic; they have been waged with stock and share, with rates and tariffs, with bills and franchises (concessions). The combatants have been financial magnates who wield the destinies of vast enterprises and range from sea to sea with their commercial activities.

For Railway business is a very manifold and complex affair, more, much more, than laying down rails and causing trains to run along them. The overcoming of great physical difficulties is not all, nor even is the perfecting of machinery to make greater and greater economies. Strategy of a kind there is in the direction of the Operation side, for example, particularly when the normal movement of trains is upset and revision of train workings has to be undertaken. Single-line working on a poorly equipped line produces a more plentiful crop of daily puzzles than most things, what with keeping balance of rolling stock, making efforts to comply with demands, and avoiding the production of blocks. Many contingencies have to be provided against and all sorts of supply and administrative problems constantly solved. All this of course is worse in War, and there is more hurry for the solution.

To the mind of the present writer there is a very clear distinction between the Management as such of a railway property and the Working of the business. The latter is, under the General Manager, in the hands of the various heads of departments—executive officers who maintain the line and the buildings, make the trains run, buy the stores, work the telegraphs, and so on, but who have comparatively little to do with the actual functions of Management. Again there are the various officials who are concerned with the commercial side of the undertaking, with whom the public has to deal and who collect

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the revenue. I do not propose making more than a passing reference to accounts, but may remark that in any financial system there must be in principle a clear line of demarcation between the making of the bargain with the purchaser, the receipt and accounting for cash, the authorization of expenditure, and the accounting for that expenditure—particularly as to the last two items. Authorization of expenditure is one of the functions of management, but accounting and audit of accounts is of the nature of a check, and is a subsidiary operation, very important, it is true, but merely following on the initial act.

As regards the Working of Railways in War, the idea that actual working and management would usually be undertaken by a *military* body is disappearing. A railway is not like other forms of transport, which are used simply where they are wanted and can be turned to other use when the war is over. A railway, being constructed in one place, has the elements of permanency—more especially as the idea of using light temporary lines has been relegated to remoteness. No, we may reckon that any railways we may use in war will—as regards their principal lines at all events—stay where they are laid down; and if they are constructed for the purposes of the war will usually remain afterwards with the idea of developing the country after peace has supervened.

We may as well recognise then that the line, even if during war it is used merely to convey military traffic, which is improbable, will sooner or later have to handle commercial traffic, and, that being so, that its management should be adapted to an eventual change. It must not be simply a concern which has to be worked at so much cost, but must keep accounts of its receipts as well as its expenditure. For the matter of that, the vouchers which would record what is carried would be of great value for tracing purposes and so on, as well as providing the foundation of a system of accounts analogous to those used under peace conditions—not that railway accounts are free from complexity! Even in war time a watch has to be kept on the working cost of the railway, especially if the system to be operated, whether taken over by capture or otherwise and in whatever way it may be staffed, is a large one. Even if the line utilised for military purposes is under civil management the army has a strong interest in its economical working, for the cost of military transport will in some form or other form part of the cost of the war. Naturally, the waging of war is not a thing where cost is the first consideration—to limit the scope of action by mere money considerations would put a stop to all generalship—but there are the strongest reasons for economising where economies can legitimately be effected. Thus the Military Controlling Staff has a good reason for making any efforts it can to secure that the methods of operating the railway are sound. But it cannot do this efficiently without some acquaintance with the

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economics of working. Now, when I say economics, it is as well to endeavour to remove the possibility of misapprehension. In this connection it does not mean an abstract and abstruse study of figures and statistics, but it does mean a knowledge of the methods by which the commercial management is carried out, the way in which watch is kept over the expense of working as compared with the receipts from week to week, and the way in which the financial aspect of schemes, modifications in practice, train workings, and so on are considered. Not many officers have the chance of seeing anything of the interior working of our English railway systems; and those who do commence as a rule with no more than a rudimentary knowledge of the mechanical processes of working, and very possibly leave off with no more than that knowledge somewhat improved. Really, management cannot be learnt from the outside, except from a manager (and he is hard to get at as a rule), unless the learner has at least some previous familiarity with the subject. This is no paradox; the bearing of the remark lies in the fact that training on an English railway is, under existing conditions, of little use until one has a clear idea what to learn. It is the same in learning most trades, but the time for learning what we want to know can only be short.

The "outdoor" business is easy enough to understand; that is mainly a matter of close observation and an enquiring mind. Again, the system of arranging trains is not difficult to assimilate, though actual practical work is a matter of long experience, and the complexities of train rules and the principles underlying them are not grasped in a moment, otherwise these subjects would not have stimulated such a large outflow of writing as streams from the press. The "indoor" affairs, that is the practical business management, are not so easy to get hold of, particularly as railways, like many other commercial concerns, are a little inclined to be secretive about their reasons for adopting any particular policy.

Railway economics are at all times a pretty thorny subject, and it takes a good deal of reading to get much grasp of them. They have perhaps aroused more public interest of late; witness the newspaper storm which was raging not so long since round the Big Wagon question, and the arguments for and against the use of ton-mileage statistics.

The question of railway Rates for the carriage of merchandise is a perennial one: you can see a good deal about it in the writings of Acworth, Pratt, and others. In America, for instance, the agitation for some form of Government control is getting strong, partly because there railway management is not as conservative as over here; partly because the President has taken a hand in the game; partly because rates, rebates, and concessions are some of the instruments by which the "Trusts" maintain their dominant position in the trade of the country. On the Continent, rates are to a great

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extent regulated by Government, with the result that (1) they can be used to influence trade, (2) changes are almost intolerably tedious to arrange. In this country the agitation about statistics is probably entangled with the rates question, for a fresh generation is constantly arising which cannot understand why the cost of carrying goods has so little to do with the amount charged for the service, or why the exact cost cannot be stated.

But how can one talk with knowledge about these railway problems unless he have some insight into the way in which railway accounts are kept and the way in which rates are made! Still less can one expect to deal with the management of a system unless he understand something of them at least.

The expression "deal with" is used advisedly, for I am thinking of the position of the controlling authority in the case where the railway in a theatre of war is still being run under civil or semi-civil management, but is employed for the transport of troops and munitions of war. It is unlikely that civil traffic can be altogether suspended. In many countries, under present conditions of civilization, the stoppage of railway traffic would be attended with disastrous results to the civil population—it is well known how the upset of railway traffic in Russia during the late war has reacted on the economic situation—and so long as civil traffic is carried many of the complex problems of commercial working must exist, and cannot be neglected by the officers employed in the controlling branch.

No one who has ever thought seriously about the matter is likely to deny that, if we had war in England, we must either have a proper system of military control over the working of our railways, or else suffer a general reign of chaos and confusion. The existing body which might be supposed to blossom into a central controlling organization is the "War Railway Council"; but this is essentially a peace concern. Control of the railways in war, like command of an army, is a 'One man show,' and a council like this, with military, naval, and civil constituents, is more adapted for academic discussion of questions in peace than for dealing with sudden developments in war—its machinery is too cumbrous and yet insufficient; in war, moreover, its members would severally have their hands full enough with their own proper affairs. The war organization must be something with a head and body; decentralization is essential, or the amount of business to be tackled will soon be sufficient to choke it. For all that, the presence on this peace council of members representing the commercial world is a guarantee that the commercial aspect of working will not be neglected.

"An army marches on its belly." True enough, but nowadays an army does not always march; that is, it is not likely to be connected with its base by march route only. It is more like a sort of crawling animal with a striking head (the fighting force) at the end of a long

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and vulnerable neck (the line of communications). So much depends on the communications and their efficiency as to make their good organization a most essential factor in the success of the campaign.

Of course it is not right to argue from one or two campaigns only, but the fact remains that both in South Africa and in Manchuria the lines of communication worked with smoothness and efficiency, consequently we hear comparatively little about them; but in both cases the railways played a great part.

In another campaign things may be started at greater pressure, events may move more quickly, and then woe betide the General whose communication service is the less efficient.

Casting our eyes over possible theatres of war, how many can we think of where the railways will not be the main agencies by which the opposing armies will be supplied. Further back I alluded to the "Strategy of Great Railroads" and the matter of control of railway systems. In war we must have and will have a military control of railway working, so that at least the same word crops up in both connections.

Now, is it likely that the financial magnates who control great railway systems are unacquainted with the practical business of management? Or do they rely on their assistants for technical points? I think not. The analogy to the position occupied by the Director of Railways and his staff is sufficiently near. If they are not acquainted with the practical business of management—and you see I have distinguished between management and purely executive work—it is sufficiently certain that, bar miracles, they will not get the maximum amount out of the railways. It is not to the point to argue from the experience of a couple of recent campaigns or from what has been done by exceptional men. Another time the conditions may be of an entirely fresh kind.

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NOTES ON THE COBHAM OPPIDUM.

By Bt. Col. O. E. Ruck, R.E., f.s.a., Scotland.

This Pre-Roman defended British Oppidum site is typical of a similar class of Celtic and Brigantian works—usually in the form of Hill Forts—to be seen elsewhere in England and Wales, Scotland, and Normandy.

A work very similarly designed is to be found in Castel-y-gaer, Llwyngwril, Merionethshire, consisting, as at Cobham, of a lunar defence on north-east side of similar ramparts, fosse, and outer mound, facing antient British Road passing across the front. The rear of Castel-y-gaer, like Cobham, is undefended, owing to the natural steepness of the approach to the top plateau from that side; the fosse runs out in the same way to lower ground on both sides, as at Cobham. But on the inside of the inner rampart (per contra) at Castel-y-gaer may still be seen the perimetrical founds of an antient masonry wall, thus differentiating the type from Cobham, and pointing clearly to a later date of construction. This variation is what might have been expected, looking to the historical evidence; for, it was not until even so late a date as A.D. 48 that Ostorius Scapula began to pave the way for the defeat of the formidable tribe of the Silures of Wales, which, with the capture of Caractacus, took place A.D. 50.

The Cobham Oppidum works, on the other hand, may safely be attributed to an earlier date; possibly before the famous Roman Raid in B.C. 43 under Claudius Plautius, whose historical crossing of the river Thames between Higham and East Tilbury—where an antient ford is reported to have existed—is even at the present day a subject of local tradition.

What makes the oppidum at Cobham somewhat exceptional is the excellent state of preservation of the curious pits and causeways in the fosse, which are common to many hill forts; these are supposed to be connected with the immediate defence of the main entrances, enabling armed men to quickly advance to and return from the outer ramparts and guard the entrances.

A doubtful point in the Cobham oppidum is the defence of the west side. In other cases a defended annexe for cattle in British works, or for camp retainers in the case of Roman Forts, is frequently to be found on the protected flank away from the most probable direction of the main attack. The mound where the water gauge now is may have been such an annexe, but the remains are too vague to form a definite opinion on this point.

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The only piece of possible Roman reconstruction work in the Cobham oppidum is the straight trench on the west side of the Park railings. Enquiries have been locally made as to whether this straight work is comparatively recent; but no information being obtainable as to its probable date of construction, nothing can therefore be authoritatively laid down as to this matter.

Earthwork structures of kindred type may often be seen, scattered over the fair surface of Great Britain. Often, however, the theories to which they have given birth have shown a great want of the simplest knowledge of military science. Those who have the advantage of being in the Corps of Royal Engineers are therefore fortunate in being able to bring to bear the practical knowledge gained in their profession, and thus emulate the example our pioneer of scientific military archæology, Major-General William Roy, R.E., who, in his "Military Antiquities of the Romans in Britain," A.D. 1793, originated a distinctly new line of research. As with other subjects initiated by us, great developments have resulted at the hands of faithful disciples and followers.

Considerable light can be thrown on many obscure points connected with these antient fortifications, until recently imperfectly understood, by a correct interpretation from a military point of view. Taking the Cobham Oppidum as a case in point, can anything be gathered from an inspection of the work and its surroundings as to the tactical and strategical fitness of those who designed it, presumably the military engineers of the Cantii? A comparison with modern practice at once supplies a ready answer. It can!

The evidence required was supplied quite recently during a staff ride. Various officers under examination for tactical fitness in command of a large force defending the heights north of the Medway against a pushful invader crossing from the south side, having omitted to watch and guard against a turning movement over the fords near Wouldham, retired on the Cobham heights only to find themselves already forestalled by the invaders, who had crossed the Medway and stolen up the Cuxton valley and through the screening woods of Cobham Park. But it was not so with the Cantii tribal engineers. For, from a study of the antient works themselves, it will be seen that their tactical technical advisers, when throwing up the main work at Cobham Oppidum, craftily designed two flanking subsidiary works commanding the Cuxton valley, one of concentric trenches in Cobhambury Wood, the other slightly in echelon of polygonal trace in Henleys Wood near Camer. The works are there now, and ocular demonstration will bear witness to the soundness of their judgment in guarding against a possible outflanking movement. Thus once again is proved the continuity of those eternal principles of fortification which the flight of time appears only to serve in indelibly branding upon our transient memories.

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MEMOIR.

MAJOR L. P. CHAPMAN, R.E.

THE Corps has suffered a severe loss by the death of Leonard Palmer Chapman on the 18th February, 1906.

Born on the 22nd June, 1865, he accompanied his parents to New Zealand at an early age, and passed his boyhood there. He was educated at Christchurch, passed into the Royal Military Academy in 1883, and received his commission in the Royal Engineers on the 9th December, 1884.

After the usual course at the School of Military Engineering he was ordered to India, and joined the "Queen's Own" (Madras) Sappers and Miners at Bangalore. With that distinguished corps he soon saw active service, taking part in the Burmese War and the Chin-Lushai Expedition. During the former, at Fort White in 1889–90, with only 5 years' service, he commanded a company of Sappers and Miners, and acted as Commanding Engineer of the northern column under the late Colonel Skene, 42nd Gurkhas. For these services he received the Indian Frontier medal with three clasps.

In 1893 he joined the Military Works Department, and was employed in various grades at Mhow, Fort Sandeman, Quetta, Naini Tal, and Aden, until he was advanced in 1903 to the onerous position of Commanding Royal Engineer at Bombay.

Comparatively young for so responsible a post, he came to it with no lack of the necessary qualifications. He was, in fact, more than usually fitted for independent administrative and executive work. His was always a clever, active brain; varied experience had given him breadth of view; constant application had brought thorough professional knowledge. Those who worked with him know how much he helped them by his clear insight, tact, common sense, sound advice, consideration for subordinates, and genial manner towards all with whom he had to deal.

But of late years his physique was not what it had been in his early manhood. Constant overwork had gradually sapped his vitality, and he suffered much from weakness of the lungs. Early in 1906, after he had been ill for about a month, it was found necessary to operate for appendicitis. He survived the operation, but had not sufficient strength to rally after the shock.

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So passed from among us one of whom it may be truly said that he never had an enemy. In private life he was universally popular, and took an interest in all games. He will long be remembered for his unfailing good temper, his cosmopolitan knowledge, and his sympathetic nature.

The esteem in which he was held at Bombay was clearly demonstrated by the attendance at his funeral of a vast crowd of mourners, including all sorts and conditions of men from the Admiral of the East India Station down to the native menials of the Military Works Office.

He was buried at Sewree Cemetery on the 19th February under peculiarly sad circumstances; for his young widow was then lying at the crisis of an attack of enteric fever, ignorant of her bereavement and forbidden to be told of it for many days.

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TRANSCRIPTS.

THE ENGINEERS OF THE RUSSIAN ARMY.*

By Capt. Bvté. du Génie Douchy.

ORGANIZATION.

The Russian Engineer troops are divided into:—

1. Field Companies.
2. Fortress Companies.
3. Technical Units.

Technical Establishments.

Under the last heading are included:—

(1). The *Electrical School.* This is intended to provide a certain number of officers and non-commissioned officers of the sappers with a practical knowledge of electricity, and to adapt new discoveries to military requirements.

(2). The *Electrical Section*, to which is attached the *Balloon Park.* The Electrical Section does no teaching, but carries out experimental work. The Balloon Park forms a school of instruction for officers who are temporarily attached to it; in addition it carries out experiments, and manufactures and repairs balloons.

Fortress Troops prior to 1904.

In Russia the Fortress Troops, whether infantry, artillery, or engineers are quite distinct from the field troops. Before the war the Fortress engineers consisted of:—

11 Fortress companies and 4 skeleton detachments.
11 Companies of submarine miners.
7 Telegraph sections.
6 Balloon sections.
2 Siege parks.
7 Carrier-pigeon establishments.
2 Companies of river miners.

Field Troops prior to 1904.

The Field Troops consisted of:—

In Europe and the Caucasus.

25 Battalions, viz.:—one guard battalion, one grenadier battalion, 21 battalions numbered from 1 to 21, and two others called the first and second Caucasian.
2 Reserve battalions.
8 Bridging battalions.
7 Field parks (one in the Caucasus).
4 Railway battalions.

* Translated and abridged by permission from articles in the *Revue du Génie Militaire* of November and December, 1905, and January and February, 1906.

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In Central and Eastern Asia.

1 Turkestan battalion (3 field and 1 telegraph company).
1 Transcaspian battalion (2 field and 1 telegraph company).
1 West Siberian company, with a telegraph section.
1 East Siberian brigade of 2 battalions (each including 1 telegraph, 1 bridging, and 4 field companies).
1 Kwantung company, with a telegraph section.
1 Trans-caspian brigade of 2 railway battalions (6 companies each).
1 Ussuri brigade of 2 railway battalions (4 companies each).
1 Trans-amur brigade of 4 railway battalions (3 companies each), employed before the war on the Manchurian lines.

The Russian units in Asia are always maintained on a war footing. There are therefore 1,200 to 2,000 men per battalion, according to whether it has 4 or 6 companies.

Sapper and Railway Brigades.

In peace time the field units in Europe are organized in seven Sapper brigades (numbers 1 to 6 and the Caucasian) and one Railway brigade. The bridging battalions and field parks are allotted to the various brigades. The composition of the Sapper brigades is not uniform. The Railway brigade is composed of 3 battalions only (Nos. 2 to 4); the other battalion (No. 1) was, before the war, attached to the first Sapper brigade.

PEACE STRENGTHS (EUROPE).

All the engineer units in Europe are maintained on a peace footing, even in the frontier districts where other arms are maintained at their war strength; it is doubtful, therefore, whether they could mobilize in time to take the field with the other troops.

The *Guard Sapper Battalion* consisted before the war of 1 telegraph and 4 field companies, and its peace establishment was 26 officers and 647 men. The other *Sapper Battalions* had 1 telegraph and 3 field companies, and their peace establishment was 22 officers and 513 men. The two *Reserve Battalions* consisted of 3 companies each, and their peace establishment was 19 officers and 453 men. In addition each battalion had a supernumerary section.

Field Companies.

The peace strength of a *Field Company* was 4 officers, 12 N.C.O.s, and 108 sappers (some are now on a higher establishment).

Bridging Battalions.

The 8 *Bridging Battalions* consisted of 2 companies each. The peace strength of a battalion was 12 officers and 277 men.

Field Parks.

The *Field Parks* were divided into sections, one section being allotted to each army corps. Nos. 2, 3 and 4 field parks had 5 sections each, Nos. 1 and 6, 3 sections, No. 5 and the Caucasian field park had 2 sections each. There are two officers and a small detachment with each park.

Railway Battalions.

The 1st *Railway Battalion* was a skeleton battalion only; its strength was 8 officers and 98 men. The 2nd, 3rd, and 4th had 4 complete companies and 1 skeleton company each. The strength of a company was 4 officers, 12 N.C.O.s, and 111 men. The strength of a battalion was 25 officers and 623 men.

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On mobilization the brigade staffs of all but No. 6 Sapper Brigade are abolished. The brigades are broken up, and the 25 battalions join the 25 army corps. Mobilization.

The battalion commander becomes in war time the commanding engineer of the army corps.

War Strengths (Europe).

The war strength of a *Field Company* is 4 officers, 20 N.C.O.s, 217 sappers, and 3 tool waggons. Field Companies.

The first two companies of a battalion are each attached to a division, the third company joins the corps troops. Nos. 1 and 2 Companies each have bridging equipment (carried on 6 three-horse waggons) capable of making 70 feet of mixed bridge (trestles and pontoons). The third company has no bridging material.

The *Telegraph Companies* on a war footing had two air line sections, with 17 miles of wire each, and one field cable section with 23 miles of cable. The war strength of a company was 7 officers, 54 N.C.O.s, and 155 men, with 52 three-horse or 48 four-horse vehicles. The office equipment was sufficient for 12 telegraph and 6 heliograph stations. Telegraph Companies.

The Sapper Battalions have all their equipment and vehicles with them during peace.

On mobilization the *Reserve Battalions* of sappers were increased to 6 companies each, and also provided a detachment of N.C.O.s and men to form a nucleus for a depôt battalion. The reserve companies when mobilized have the same strength as the field companies, but they had, till recently, no bridging equipment. Their waggons and equipment are stored with the reserve battalions during peace time. The reserve battalions are not detailed to any special units; they would probably not join the reserve army corps, but would either reinforce the first line troops or be allotted to the lines of communication. Reserve Battalions.

Depôt Battalions.—On mobilization 4 *Depôt Battalions* are formed, 2 to each reserve battalion. They are composed of 4 field companies, 1 telegraph company, and 1 submarine mining company. Eighteen captains and eighteen subalterns are withdrawn from the first line battalions, and posted to the four depôt battalions. The remaining officers are drawn from the engineer establishments and reserve of officers.

The staff of a depôt battalion consists of 17 officers and 277 men. Its total strength is 1,650 men.

The duty of the depôt battalions is to train reservists, and to forward them to the field and fortress companies as required.

The *Bridging Battalions* on a war footing consist of 2 companies only. Their strength is raised to 12 officers, 580 men, 495 horses, and 122 waggons, of which 102 carry bridging equipment. Bridging Battalions.

Each battalion has 245 yards of floating bridge and 51 yards of trestle bridge. The equipment is divisible into four sections, consisting of 65 yards of mixed bridge each.

The bridging battalions are not detailed to the army corps, but are placed at the disposal of the general staff. They are in fact 'army troops.'

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Field Parks.

On mobilization a section of a *Field Park* is attached to each army corps. Each section on a war footing consists of 1 officer, 45 men, 12 four-horse or 19 three-horse vehicles, and 48 to 62 horses.

Each section carries 2,700 shovels, 552 axes, 72 mattocks, 16 saws, 120 picks, cordage, small tools, topographical instruments, sandbags, augers, wire, bridging stores, demolition stores, and a little telegraph material.

Railway Battalions.

On mobilization each *Railway Battalion* in Europe has 2 construction and 2 traffic companies. The fifth company forms the nucleus for a reserve railway battalion of 1 construction and 3 traffic companies. The war strength of a railway battalion is 25 officers, 1,112 men, and 42 waggons (only 17 for a reserve battalion).

RECAPITULATION.

PEACE STRENGTH (EUROPE) PREVIOUS TO 1904.

Unit.	Officers.	Men.	Horses.
8 Brigade Staffs	32	48	—
25 Battalions of Sappers 1st line (one had 5 companies)	554	12,959	113
2 Reserve Battalions of Sappers	38	906	18
8 Bridging Battalions	96	2,216	96
7 Field Parks	14	227	7
4 Railway Battalions (one a skeleton)	83	1,967	32
Totals	817	18,323	266
Or including the troops in Asia, about	1,200	36,000	1,000

WAR STRENGTH (EUROPE) PREVIOUS TO 1904.

Unit.	Officers.	Men.	Horses.	Carts.
25 Battalions of Sappers (1st line)	654	28,035	8,050	3,085
2 Reserve Battalions	62	3,072	160	64
4 Depôt Battalions	68	6,600	48	—
8 Bridging Battalions	96	4,640	3,960	976
25 Sections of Field Park	25	1,125	1,386	391
7 Railway Battalions (3 reserve)	175	7,784	442	219
Totals	1,080	51,256	14,046	4,735
Or including engineer staffs and troops in Asia, about	1,700	72,000	16,000	6,000

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Inspector of Engineers.

The Inspector of Engineers in each military district becomes on mobilization Inspector of Engineers for the corresponding army. He is placed under the orders of the Chief Staff Officer, but has the right of communicating directly with the Army Commander.

The duties of the Inspector of Engineers are:—

(1). The organization of important defensive positions.

(2). The construction and repair of important roads and bridges within the zone of operations (not on the lines of communication).

(3). The maintenance of telegraphic communication between headquarters and the various army corps, and between headquarters and the base.

It will be noted that, though the Inspector of Engineers is responsible for the maintenance of telegraphic communication, he has no telegraph companies under his immediate orders. The latter, being an integral part of the sapper battalions, are under the orders of the army corps commanders. This fault became apparent during the war, and is now being remedied by the formation of army telegraph troops, as will be explained later.

Commanding Engineer of an Army Corps.

The Commandant of a Sapper Battalion becomes, on mobilization, Commanding Engineer of the army corps of which his battalion forms part. He commands in person the field company, the telegraph company, and the field park, which form part of the corps troops. If there is a bridging unit with the army corps, he commands that also, unless it amounts to a whole battalion, when it is left under the command of its own commandant. The Commanding Engineer is placed entirely under the orders of the Chief Staff Officer, unless the army corps is detached, when he has the right of communicating directly with the army corps commander. The Russian sapper officers consider that he should always have this right.

Russian Comments.

Many Russian military writers consider that the bridging material with an army corps is insufficient, and advocate that the third company (corps troops) of each Sapper battalion should have the same equipment as the divisional companies.

TRAINING.

Sappers.

The Sapper companies are separated in peace time from the units of the other arms with which they would co-operate in war. It is considered that this is necessary, in order that they may be given a more complete and technical training. The instruction is supervised by a member of the Engineers Committee, who holds the appointment of Inspector General of Field Engineers.

The technical instruction of the Russian sappers is good; but the infantry and engineers have not sufficient practice in working together, and the commanders of the larger units (divisions and army corps) do not know how to utilize their sappers.

During the winter the sappers cannot carry out any practical work; their instruction is therefore limited to theoretical teaching and work in the model sheds.

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Camps and Manœuvres.—In May instructional camps for all arms are formed, as few men as possible being left behind in barracks. In camp each arm is trained by itself for a time; then mixed forces of all arms are formed, and manœuvre together for a few days. Finally larger units (divisions and army corps) are formed, and leave camp for the 'small manœuvres.' These last for two or three weeks, and are followed by 'grand manœuvres.'

Comments on Manœuvres.—The result of these manœuvres has been, from the Engineers' point of view, far from satisfactory. The sappers have either been employed on work which should have been carried out by other arms, or they have been treated as a spare company of infantry, or else they have been forgotten altogether. The reasons for this failure appear to be—the commanders of the larger units do not know how sappers should be employed, there is no time to carry out any but insignificant works, and the sappers are not allowed to expend either money or stores.

The fact that the commander of a sapper company is dismounted seriously impairs his efficiency.

Bridging Units.

Details of Training.—During the annual camp the field companies and bridging battalions practice both hasty and semi-permanent bridging. Bridges of the latter type are constructed of wood, and necessitate the employment of smiths and carpenters. After a sapper has been instructed in entrenching, demolitions (and bridging?) he is detailed to learn some particular trade. In each field company there is a detachment of 20 men of selected trades, who are trained for railway work. They are exercised on light railways laid in proximity to the annual camps and, to some extent, on the lines near their garrisons.

Telegraphs.

In the telegraph companies a minimum of 70 N.C.O.s and men are trained as operators.

Railway Troops.

The Asiatic railway troops are permanently employed on the Asiatic railways. They are experts, but cannot be considered as available for mobilization. The 1st European Railway Battalion is only a skeleton unit; the 2nd, 3rd and 4th are employed each year on construction work, but get no practice in traffic duties.

The Russian Engineer officers consider that the railway battalions should be exercised on a line from 75 to 100 miles long, working at high pressure.

OFFICERS.

Training.

Theoretically the officers for the Russian sappers are drawn from the Nicolas Engineering School, but for many years the output of this institution has not been sufficient. The remaining vacancies are therefore filled by officers from other military colleges. The latter are posted to the sapper companies without having to pass any special examination; after a year on probation their appointments are confirmed, if they obtain satisfactory certificates.

The number of officers posted to the sappers every year amounts to from 80 to 150, of whom only from 60 to 90 come from the Nicolas School. About half of the officers obtained from other sources leave the sappers before completing the probationary period.

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During an officer's third year of service, he is allowed to compete for the Military Engineering Academy. There are about 170 candidates each year for 45 vacancies. The ordinary course lasts for two years, but most of the pupils are allowed to go through a supplementary course which lasts another year. At the end of the third year those who have been most favourably reported on become 'Military Engineers' (as distinct from sapper officers); the others are sent back to the sappers.

The Staff College.

In addition 6 or 7 officers are admitted each year to the Staff College. At the end of the course, some are posted to the general staff and the rest are sent back to their companies. An officer once on the staff never reverts to duty with the sapper companies.

Unpopularity of Service with the Sappers.

The changes among the subaltern officers with the sappers are very frequent. Those who fail to enter the Academy do their best to obtain other employment. Some try to enter the Guard; others apply for instructorships to cadet corps; others go to the commissariat, or to the sapper companies of the St. Petersburg garrison; some even obtain transfers to the cavalry.

System of Promotion.

The chief causes of the unpopularity of service with the sappers are the slowness of promotion and the large amount of extra work as compared with the infantry. There are some captains of 28 years' service in the sapper battalions. The normal rate of promotion is to first lieutenant after 4 years' service, and to captain after 8; all subalterns are promoted after 12 years' service. Promotion to the rank of Lieut.-Colonel is only given when there is a vacancy.

In addition there is accelerated promotion. This is given:—

(1). To selected officers, in the proportion of three per cent. of the vacancies.

(2). To officers who have served with the Guard on reversion to their own battalion, or to officers who have completed a course at one of the academies. If an officer completes two or more such courses, he is allowed to accumulate these advantages. Officers promoted under the second heading are usually Lieut.-Colonels at from 30 to 35 years of age, Colonels at from 34 to 38, and Brigadier-Generals at from 42 to 46. At this latter age the ordinary sapper officer is still often a captain.

Russian military writers consider that the conditions of service must be ameliorated, before a sufficient number of officers of the right quality can be obtained for service in the sappers.

Military Engineers.

The Military Engineers never serve with troops during peace, and it therefore appears desirable that they should be posted to sapper companies from time to time.

DUTIES OF ENGINEERS IN WAR.

Defensive Positions.

In taking up a defensive position, the general line is selected by the staff assisted by the commanding engineers of divisions and army corps; the exact site of the trenches is fixed by the infantry. The sappers are employed on the defence of villages and woods, the construction of obstacles, field redoubts, and blindages. Gun epaulments are constructed by artillery, assisted by infantry from the reserve. Communications are made by infantry working under the guidance of sappers.

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Telegraphs. The duties with regard to telegraphs are to connect the army headquarters with the main telegraph system of Russia, the army corps with army headquarters, and the divisions with the corps headquarters. These duties are stated in the order of their relative importance. The commander of the lines of communication takes over the field lines in rear of the army, and replaces them by permanent lines, forwarding the field material again to the front. Telegraph lines are maintained by the units that have erected them.

The telegraph companies work in three parties; one party laying and operating new lines, one removing or operating old lines, and one resting. The normal rate for erecting air lines is said to be 2 miles an hour, but this is the maximum attained on manœuvres. Cable is laid at from 2 to 2¾ miles an hour.

Railways. On the declaration of war all the Russian railways and railway material are placed at the disposal of the Minister for War.

For railway repairs there are available, (*a*) 20 men per field company who have been trained in railway work, (*b*) the construction companies. It is doubtful whether the former (*a*) would be really available for employment; and as regards the latter (*b*), there are only 11 construction companies in Europe, of which 3 belong to the reserve. (By way of comparison it may be stated that Germany has 63 construction companies). There are 17 European traffic companies, of which 9 belong to the reserve. The civilian railway staff in Russia is not organized for employment in war.

All Russian writers agree that Russia has too few railway troops.

INCREASES DUE TO WAR IN FAR EAST.

European Units.

Fortress Troops. In 1904 one new fortress company was raised. On mobilization this forms 2 companies for employment in the Baltic fortresses.

Submarine-Mining Companies. The submarine-mining companies in the Far East were raised from 3 to 5 (one at Port Arthur).

Fortress Telegraphs. An extra fortress telegraph section was formed at Port Arthur.

Fortress Balloons. Two new fortress balloon sections were formed, one at Vladivostock and one at Port Arthur; the latter never received its equipment. In February, 1905, the new balloon section at Vladivostock was expanded to a company (a new balloon unit). In April another fortress balloon company was raised at Warsaw.

Strength.—The peace strength of the new fortress balloon companies is 7 officers, 137 men, and 12 horses; and the war strength 12 officers, 188 men, and 92 horses. They have 9 spherical balloons, 9 elongated balloons, 2 elongated balloons for wireless telegraphy, 100 small balloons for signalling, and 3 gas generators employing caustic soda and aluminium.

Siege Park. An engineer siege park, composed of two sections, was formed at the end of 1904 for the Far East. Its war strength is 4 officers, 485 men, 402 horses, 320 two-wheeled carts, and 37 baggage carts.

Carrier Pigeons. Carrier pigeon establishments have been increased from 7 to 10.

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River Miners.

The Vistula company of river miners was mobilized for service on the lower Amur, and became the Far Eastern Company. It is not known whether a new company was raised to take its place.

Field Engineer Troops.

Orders were issued for the formation of a new army corps in Finland during 1905. This would entail the formation of a twenty-sixth sapper battalion. In view of the political situation it is doubtful whether the order will be carried out.

In August, 1905, the formation of 10 new sapper companies was ordered. These are allotted to battalions 3, 4, 10, 11, 14, 15, 18, to the 1st and 2nd Caucasian battalions, and to the Guard battalion. Each of these battalions therefore now consists of 1 telegraph and 4 sapper companies, except the Guard battalion which has 5 sapper companies. The remaining battalions still have 1 telegraph and 3 sapper companies each.

Strength.—The new companies are to be kept permanently at war strength, viz., 239 men for the guard, and 337 for the other companies. The telegraph companies of the enlarged battalions are also to be maintained at war strength, viz., 253 men; this is an increase of 44 on the war strength of the other telegraph companies.

Mobilization.—On mobilization the 10 new sapper companies and the 10 higher establishment telegraph companies form 2 companies each. Out of these, 20 sapper and 10 telegraph companies are detached from their battalions and allotted to the reserve. It seems probable that they will eventually be formed into battalions of 1 telegraph and 2 sapper companies each, and attached to the reserve divisions.

Reserve Battalions.

After some intermediate changes, 3 new reserve battalions, each containing 1 telegraph and 2 sapper companies (with bridging equipment), were formed in August, 1905; and 1 telegraph company was added to each of the 2 original reserve battalions. On mobilization the number of reserve companies in a battalion is not doubled as formerly; the 5 battalions therefore furnish 12* field and 5 telegraph companies.

Bridging Battalions.

In December, 1904, the 1st Bridging Battalion was raised from 2 to 4 companies, supplied with a new bridging outfit, and sent to the Far East.

Before 1905 there were no reserve or depôt bridging units; now a third company has been added to the 3rd, 4th, 5th, and 7th Bridging Battalions. On mobilization these new companies are doubled, and form 4 reserve bridging battalions of the same strength as the first line battalions, viz.:—13 officers, 632 men, 496 horses, 56 waggons carrying half-pontoons, 32 waggons with superstructure, and 20 baggage waggons.

Field Parks.

Ten new field park sections were formed in 1905. These were attached as follows:—1 to each of parks Nos. 1, 2, 3, and 5, and 2 to each of parks 4 and 6 and to the Caucasian park.

Railway Battalions.

The 3rd Railway Battalion was mobilized and despatched to the Far East, and its fifth company formed the 3rd Reserve Railway Battalion.

* The two original reserve battalions have still 3 field companies each.

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This also was sent to Manchuria, and joined the Trans-Amur Railway Brigade.

Since October, 1904, railway troops have been separated from engineer troops.

ASIATIC UNITS.

Sapper Battalions.

At the commencement of the war there were nominally in the Far East only the two Siberian battalions and the Kwantung company. As a matter of fact a third battalion had been already raised. Each battalion consisted of 1 telegraph, 1 bridging, and 4 field companies.

A fourth battalion was raised in February, 1904, to form part of the 4th Siberian Army Corps. It was composed of 1 field park section, 1 telegraph company, and 2 field companies.

A fifth and sixth battalion were formed in June, 1904. They were similar in composition to the fourth battalion, but the fifth had double the bridging equipment. It is probable that the last two battalions were formed by drafting units from Europe.

Telegraph Units.

Each army corps had originally a telegraph company forming part of the corps troops. It was soon found, however, that 'army telegraph troops' were required as well. To this end an East Siberian telegraph battalion was formed in August, 1904, consisting of 4 companies with a total war strength of 26 officers, 1,074 men, 745 horses, 160 telegraph waggons, and 85 baggage waggons. Each company was composed of four air-line sections.

A second telegraph battalion having the same establishment was formed in January, 1905.

At the same time 3 independent telegraph companies were formed in Europe for wireless telegraphy. Each company had an establishment of 10 officers, 426 men, and 258 horses, and had 6 Marconi installations.

In May, 1905, two mounted telegraph units were formed; one a half-squadron, strength 4 officers, 106 men, 113 horses, and 16 waggons; the other a sotnia, strength 4 officers, 101 men, 132 horses, 11 waggons, and 23 pack animals. These units were formed at St. Petersburg. They carry telegraph, telephone, and visual signalling apparatus, and 24 versts of cable; and are attached to the headquarter staff. They are expected to lay from 7 to 12 versts of cable per hour.

In May, 1904, a new telegraph company was formed in Turkestan.

Depôt.

In June, 1904, a depôt battalion was formed at Omsk. In March, 1905, this battalion moved to Kharbin, and was formed into a second reserve telegraph company, with a strength of 4 officers and 275 men.

Bridging Units.

In February, 1904, there were 3 bridging companies in Siberia, forming part of the three East Siberian Sapper Battalions. When the 4th, 5th and 6th East Siberian Battalions were formed, they were not given any bridging companies, because it had been decided to organize these as independent units (army troops).

An East Siberian Bridging Battalion of two companies was formed in March, 1904, and provided with bridging equipment on double the usual scale. At the end of 1904 the 1st European Bridging Battalion was sent to the Far East; and orders were issued for the formation of the 2nd and

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3rd East Siberian Bridging Battalions, of the same strength as the 1st, but with only the normal amount of equipment.

In May, 1904, orders were given for the formation of a bridging company in Turkestan.

Field Parks.

In addition to the new sections of field park that were raised for the new East Siberian Sapper Battalions, a section of the 3rd European Park was sent out to the Far East.

In May, 1904, an Engineer Park of two field and two siege sections was formed in Turkestan.

Railway Troops.

The 4 battalions forming the Trans-amur railway brigade were raised to a strength of 6 companies each before the end of 1904. In February, 1904, the Transcaspian railway brigade had been given another company, but it subsequently transferred 2 companies to the Trans-amur brigade. It is not known whether their places were taken by new companies or not.

Balloon Units.

In May, 1904, a Siberian field balloon company was raised. Its strength was 5 officers, 193 men, and 138 horses. It had 4 spherical balloons, with a capacity of 640 cub. mètres each.

In June, 1904, an East Siberian Field Balloon Battalion of 2 companies was raised by taking men from the European fortress balloon sections. The strength of this battalion was 11 officers, 340 men, 287 horses, 133 two-wheeled carts, and 42 waggons. Its equipment was 8 spherical balloons, 20 signalling balloons, and 2 gas generators (one for pack transport). The balloons took half-an-hour to fill.

In November, 1904, the field balloon company was raised to a battalion of the same strength and with the same equipment as the first battalion.

In April, 1905, a third balloon battalion was formed, strength 15 officers, 677 men, and 333 horses. This battalion has some elongated balloons.

RECAPITULATION OF NEW UNITS (EXCLUDING PORT ARTHUR GARRISON).

Fortress Troops.

1 Fortress company (forming two on mobilization). Baltic.
1 Submarine-Mining company. Far East.
2 Fortress Balloon companies. Vladivostock and Warsaw.
1 Siege park. Far East.
3 Carrier Pigeon establishments. Europe (?).

Field Troops.

10 Field companies (forming 20 reserve companies on mobilization). Europe.
4 Sapper battalions (in all 3 field parks and 1 bridging, 10 field, 4 telegraph companies), Far East.
10 Telegraph companies, establishment augmented (forming 10 first line and 10 reserve telegraph companies on mobilization). Europe.
2 Telegraph battalions (each of 4 companies). Far East.
3 Wireless Telegraph companies. Europe.
1 Telegraph company. Turkestan.
1 Reserve telegraph company. Far East.
1 Mounted Telegraph half-squadron. Europe.
1 „ sotnia. Europe.
3 Reserve Sapper battalions (each of 1 telegraph, 2 field companies). Europe.

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2 Bridging companies. Europe.
4 Bridging companies (forming 4 reserve battalions, each of 4 companies, on mobilization). Europe.
3 Bridging battalions (each of 2 companies). Far East.
1 Bridging company. Turkestan.
10 Field Park sections. Europe.
4 ,, ,, Far East (including 3 above).
2 ,, ,, Turkestan.
2 Siege Park sections (fortress unit ?). Turkestan.
12 Railway companies. Trans-amur.
1 Railway company. Trans-caspian.
3 Field Balloon battalions (each of 2 companies). Far East.

The chief point to be noted is the enormous increase that had to be made in all the technical units. On the other hand, the normal proportion of field companies, three per army corps, was apparently sufficient.

J. E. E. CRASTER.

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COAST DEFENCE IN THE UNITED STATES OF AMERICA.

THE *Army and Navy Journal* of 10th March last contains portions of the Report by a Board appointed to revise the work of the Endicott Board of 1886. The new Board, of which the Secretary for War was president, included the Chief of Staff, the Chief Signal Officer, and the Chiefs of Ordnance, Engineers, and Artillery, as well as five other senior officers representing the Navy and Army.

The Board indicate the change in conditions since 1886 which have necessitated a revision of the coast defences, but record their view that the principles of defence so clearly stated by the Endicott Board are unchanged.

The following are extracts from the above-mentioned portions of the Report:—

"Since 1886 our territorial limits have been enlarged by the addition of the insular possessions. They are distant from the great centers and sources of supply and cannot be held unless their principal ports are fortified before the outbreak of war. It is clear that the defense should be provided with as little delay as possible. Naval bases and coaling stations must be protected by fortifications and, in addition, Manila, Honolulu and San Juan are of sufficient military importance to deserve adequate defense.

The United States has secured a valuable possession, the canal zone, and is to expend large sums of money for the construction of the Panama Canal, a waterway of vital strategical and commercial importance to the United States. While it may appear that the ultimate defense of the canal must rest with the Navy, the fleet should not be tied so closely to it as to lose its offensive power; moreover, it is readily conceivable that control of the sea in the vicinity might be temporarily lost, either on the Atlantic or Pacific coast, making land defenses necessary and advisable, since the cost of fortifications would be but a small percentage of the damage which could be quickly inflicted upon the plant and operation of the canal.

After the canal is completed, the capture of or damage to either entrance might prevent the passage of war vessels between the Atlantic and Pacific oceans, though the concentration of the two fleets might be of vital importance to the national welfare."

"The Board, after carefully weighing the relative commercial and strategic importance of the ports and harbors of the United States and the insular possessions, modifies and revises the list of ports submitted by the Endicott Board as requiring defense. The revised list below is arranged in geographical order:

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HOME PORTS.

Kennebec river,	Delaware Bay,	Mobile Bay,
Portland,	Baltimore,	Mississippi river,
Portsmouth,	Entrance Chesapeake Bay,	Galveston,
Boston,	Hampton Roads,	San Diego,
New Bedford,	Potomac river,	San Francisco,
Narragansett Bay,	Cape Fear river,	Columbia river,
Eastern entrance to Long Island Sound,	Charleston,	Puget Sound,
Eastern entrance to N.Y.	Savannah,	Lake Ports,
Southern entrance to N.Y.	Key West,	Kiska Island.
	Tampa,	
	Pensacola,	

INSULAR PORTS.

Guantanamo,	Subig Bay,	Pearl Harbor and Honolulu.
San Juan,	Manila Bay,	
Guam,		

ISTHMIAN AND CANAL PORTS.

Colon,	Panama.

While the military needs of the coast as they exist to-day can be determined and provided for, the growth of the country, the construction of railways or other lines of communication may give, hereafter, a commercial and strategical importance to other ports which they do not possess at present.

Increase in gun power and the efficient operation of the disappearing gun carriage, giving an increased rate of fire, have caused considerable changes in the details of defense recommended by the Endicott Board, viz.: the omission of turrets, armored casemates and gunlifts, and a reduction in the number and caliber of guns. The cannon now mounted in seacoast defenses are the following: High-power guns;—12-inch, 10-inch and 8-inch; the rapid-fire guns;—6-inch, 5-inch, 4·7-inch, and 3-inch; and the 12-inch mortar.

A demand for heavier armament and better armor protection has led to a marked increase in the tonnage of battleships. Battleships of 18,000 tons and upwards, mounting twelve to fourteen 12-inch guns with a great increase in armor protection, have been projected. Land guns must keep pace with such advance."

"The 12-inch gun can now fire two aimed shots in less than a minute, manual labor being used for loading and operating the gun and carriage: it is believed that this rate will not be materially diminished if the 14-inch gun mounted on a disappearing carriage of the same type as that now employed for the 12-inch gun, loaded and operated by the same means, be adopted. For the 16-inch gun, however, mechanical devices must be resorted to for loading and operating—a very decided disadvantage. The cost of the 14-inch gun with the required energy is but slightly in excess of the cost of the 12-inch gun with an equal energy at 8,700 yards.

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For these reasons the Board recommends the adoption of 14-inch guns mounted on disappearing carriages for the defense of the channels above enumerated. The 14-inch projectile will carry a bursting charge of high explosive more than fifty per cent. in excess of the charge of the 12-inch projectile.

The Board is of the opinion:—

1. That the gun defense of a port of first importance should consist of guns of not less than 12-inch caliber, 12-inch mortars, and suitable rapid-fire guns for the defense of the mine fields.

2. That 10-inch guns are sufficient to cover channels liable only to cruiser attack.

3. That 6-inch guns should be used for the protection of places subject to naval raids and the special care of mine fields at distant ranges.

4. That 3-inch guns be used for the protection of mine fields at ordinary ranges.

These conclusions of the Board are based on the following considerations:—

1. Improvements in range finding equipment, the development of a system of electrical information, and the use of search-lights at night which have increased the effective range of guns ashore to such an extent that fire from the batteries will be begun at ranges upwards of 12,000 yards, whereas two miles was formerly considered the effective limit.

2. The little injury done to armored vessels, except by projectiles of large caliber, in the naval engagements between Japan and Russia.

3. The naval opinion that first-class fortifications will not be seriously attacked by anything less powerful than battleships."

"The reason the Endicott Board recommended so many mortars for coast defence was that they attacked an armored vessel in its most vulnerable part—the deck. Their special role was to prevent the occupation of anchorage areas by hostile vessels from which either the defenses or the protected ports might be bombarded. It was not anticipated that they could be effectively used against moving vessels, but by the improvement of the range finding system the usefulness of mortars to the defense has been very greatly increased and their fire is now effective against moving as well as stationary targets. o o o

There is no fixed rule for determining the number of guns required to give an adequate protection, and in arriving at a conclusion as to what should constitute the defense, the following considerations have been accepted which tend to diminish the number recommended by the Endicott Board without decreasing in any way the protection to the harbors:—

1. The development of a system of range finding, fire control and direction, much more efficient than could be anticipated at the time of the Endicott Board, which gives the land gun a very great advantage in accuracy of fire over the gun afloat, especially at the longer ranges.

2. The increased power developed in guns of a given caliber.

3. The adoption of the disappearing carriage for the higher caliber guns, thereby attaining an increased rate of fire.

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4. Ships engaged in an attack on a fortified position must have ample room in which to turn, and as war vessels are being constructed larger and of deeper draught, the defenses required for narrow and shallow channels, whether natural or dredged, may be diminished since the heavier ships are excluded.

5. If the armament will compel the enemy to land in order to effect its capture, it has fulfilled its function, and any increase in armament thereafter is an unwarrantable expense in material and personnel. o o o

The Board has recognized the claims of the Navy to command all seagoing defenses, and also the general inadvisability of assigning naval units to particular stations, yet the Board believes that the military defenses of certain important ports should be supplemented."

"It is the power of determining the range from the gun and the ability to apply all of these corrections quickly and accurately, combined with stability of platform, which gives the land gun its great advantage over the gun afloat, a superiority which increases rapidly as the range increases.

The expense of installing a proper system of range finding, fire control and direction which will accomplish the results desired is but a small percentage of the cost of the guns, carriages and emplacements which the system is designed to serve. An efficient system for any harbor can be elaborated only after the most careful study of the particular locality. o o o"

"Because of the effect of beams of light on each other, and on other auxiliaries of defense, experiments have demonstrated that the proper number and locations of searchlights in each harbor are matters that can be determined only after repeated local trials, and as a consequence the preparation of an estimate of the cost of perfected searchlight apparatus for all of the defended harbors which is more than a fair approximation, is impracticable.

A service of security and information must be provided to guard the coast against sudden hostile attack, and steps have already been taken to this end by both the Army and Navy, including the co-operation of the two services. Wireless telegraphy will form an important feature of the system for communicating with ships of the Navy and with suitably equipped scout boats employed for the purpose. o o o"

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A REPORT ON HALIFAX, NOVA SCOTIA, BY ONE OF WOLFE'S ENGINEERS.*

THE recent abandonment of Halifax as a permanent Naval station and dockyard, and the transfer of the Fortress to the Dominion Government, open a new era in the history of this once famous Imperial stronghold.

The establishment of the Dockyard in 1759—"the year of victory"—when Wolfe decided the fate of the North American continent on the Heights of Abraham, marked the opening of the first chapter in its Imperial History.

It was from Halifax that Wolfe started on his victorious expedition—one of the most memorable in the history of the Anglo-Saxon race, for it decided that the civilization of North America should be English and not French in its character; and it was to Halifax that the unsuccessful Imperialists and Loyalists retired after the Revolutionary War, on the evacuation of New York in 1783.

Although thus used as a base for victorious armies and a refuge in defeat, Halifax itself has never been the scene of actual warlike operations. The nearest approach to actual war was the entry of the *Shannon*, escorting the *Chesapeake*, after her victorious 14-minutes' action with the latter vessel on the 1st June, 1813. Perhaps even a closer approach to actual war occurred on an August night in 1864, when the Confederate cruiser *Tallahassee* ran out at night by the almost unnavigable Eastern Passage, and escaped the Federal Gunboats lying in wait for her off Chebucto Head. The graves of Captain Taylor Wood of the *Tallahassee* and of two officers of the *Shannon* are local memorials of these two famous naval exploits.

Rudyard Kipling's description of Halifax in the "Song of the Cities" is, however, perfectly correct in the impression it conveys of the absolutely peaceful existence that the Fortress has had for close on 150 years.

> "Out of the mist my guardian prows put forth;
> Behind the mist my virgin ramparts lie.
> The Warden of the Honour of the North,
> Sleepless and veiled am I."

To the student of Fortification, Halifax offers many interesting points.

* Communicated by Major B. R. Ward, R.E.

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From the original Stockade Lines alluded to in the following report, through the Bastion and Polygonal Systems—for the Citadel of Halifax, constructed at the close of the 18th Century, shows examples of both these styles—right up through the various systems adopted during the 19th Century, from Martello Towers to the most recent types of emplacements, Halifax forms a perfect museum for the military engineer.

Many reports have been written about Halifax in this connection, but probably none more interesting or by an abler hand than the following one by Hugh Debbieg, Captain and Chief Engineer under Major-General Amherst in 1761.

It has been my duty at various times during my two years service at Halifax to examine and catalogue various old military documents which have accumulated at the Headquarter Office and in the C.R.E.'s office during the military occupation of Halifax. As the last station in the Dominion to be occupied by British Troops, the documents from other formerly-occupied military stations, such as Montreal and Quebec, have drifted here. These have now been catalogued, and despatched for the most part to Ottawa, where they have been deposited with the archives of the Dominion Government.

Most of the documents that were in existence before the Revolutionary War of 1775 to 1783 have disappeared. The records from 1783 onward are fairly complete. A few older documents have, however, survived, and of these the most interesting is this first report on Halifax by a military engineer. It is interesting at the present time, when so much attention is being directed to Halifax in connection with its transfer to the Canadian Government ; and it is also interesting as having been written by one of our most famous Engineers.

Hugh Debbieg, whose biography, by Colonel R. H. Vetch, C.B., R.E., appears in the Supplementary Volume, No. 2, of the *Dictionary of National Biography*, was born in 1731 and died in 1810 as a General of Royal Engineers. His biographer writes of him in 1759 as "a man after Wolfe's own heart, resolute and daring, giving little heed to rule or system where they interfered with his views of the best mode of attack" (p. 125). He served under Wolfe as Assistant Quartermaster-General throughout the campaign of 1759 ; but during the siege of Quebec he temporarily gave up his appointment on Wolfe's staff to take his share of the engineer duties. "He was with Wolfe when he fell, and figures in West's celebrated painting of the incident" (p. 125). After the capitulation of Montreal, on the 8th September, 1760, he accompanied the army to Halifax, Nova Scotia, where he acted for a time as Chief Engineer. Both historically and professionally his report on Halifax is well worthy of preservation and study. His subsequent career as an Engineer was highly distinguished, both in peace and war.

B.R.W.

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REPORT ON HALIFAX, NOVA SCOTIA, BY CAPT. HUGH DEBBIEG, CHIEF ENGINEER, DATED 29TH MAY, 1761.

A REPORT of the Particulars relating to the fortifying of this Place, made according to Instructions from the Hon'ble Board of his Majestie's Ordnance dated 23rd May 1758 and by order of his Excellency Major General Amherst dated 14th September, 1760.

By a Report made of this place dated 12th April 1759, it appear'd that all the Fortifications which had hitherto been raised (a few Batteries excepted) were of a temporary kind, and intended as a security only against the sudden Incursions of Canadians and Indians with small Arms, and were then unfit even for that purpose from the decay'd condition they were in.

It is unnecessary to repeat the several particulars relating to them mention'd in that report; it is sufficient to tell, that nothing remains now at Halifax, which can be consider'd as a Fortification or as any part of one, so that the Business is not (in Terms of the Instructions) "to form "a general Design for the repairing or reforming each Fort and its "Buildings" but to form Designs of a Fortification intirely new. There have as yet been no particular Directions for this purpose and the Designs that are made, may possibly not tally with the Ends proposed, for according to the uses and services that may be expected from a Fortification, it is obvious that the Designs ought to be calculated as nearly as possible. These Services may be comprehended under Designs of three different Classes;

Halifax may be fortify'd for three different purposes;

The first only to protect the Inhabitants of the Town from the sudden Incursions of Canadians & Indians, such as the original Design was, and in that Case Stockade Lines with some Block houses properly placed with Ditches to the whole, may answer the purpose without going to more Expense.

1st.

The second may be a Design to secure a Post which shall prevent an Enemy, from taking Possession of or settling upon the Harbour, without bringing a considerable Armament; for this purpose, a Fort capable of containing from 500 to 1,500 men, such as was mentioned in the Report of 1759, might answer.

2nd.

The third may be a Design of more general and extensive use, that is, a Repository of Sea and Land Service Stores for a Fleet and an Army, with proper Arsenals for their preservation and a Garrison, sufficient for their Defence in time of War, from three to five Thousand men, which can afford to send small Detachments to other parts of the Province or even to the continent if occasion should require.

3rd.

The first of these Designs seems now to be no longer wanted therefore need not be spoke to.

The 1st not necessary.

The second is of a limited use and will scarce answer any purpose from which considerable Advantages can be drawn; the smallness of the Garrison will not admit of its giving much assistance without tho' wanted, and the smallness of the Fort will not admit of its containing more Stores within it than will be necessary for its own Defence and these perhaps with Difficulty.

The 2nd. of a limited Use.

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The 3d. of an extensive use.

The third Design seems to merit our chief or perhaps our only Attention, and the next questions are, whether such a Fortification is wanted in North America? and whether Halifax is a proper place for it. As far as an Engineer may speak to the first of these, it may be answer'd, that one such place in North America must be of great service both in War and peace, in War as a place of Rendezvous to make up Fleets and Armies, and to supply their Wants occasionaly without losing the time of sending to Europe, and in peace, not only as a ready check to any future attempts of an Enemy, but likewise as an additional weight to keep our own Dominions in proper subordination.

Halifax proper for the 3d.

To the other Question, Whether Halifax is a proper place for a Fortification of this Importance? It is answer'd, that the Coast of Nova Scotia, by all accounts, affords the best or rather the only Harbours in North America fit for a numerous Fleet with water for large Ships, and is by far the most commodious Coast for protecting and carrying on that fix'd object of our Attention the Cod-Fishing.

I have had a Description, which shall be annex'd, of all the Harbours along the Coast from a person reputed a good Pilot who has used them for many years. It appears by his Description which is confirm'd by others, that Halifax Harbour is by far the most spacious of the whole, and is in all other respects equal to the best and superior to most of them. It has no large Rivers runing in to it and is therefore the less lyable to have Banks and Shoals form'd within it; The situation of it is centrical, and may have ready communications to the most fertile parts of the Province; It keeps open throughout the Winter, and has a peculiar advantage in the Remarkableness of its Coast which is easier distinguish'd than any other by ships coming from Sea, and this Advantage is now assisted by a Light-House lately built on Sambro Island.

The objections against Halifax.

Halifax with these Advantages as a Port, labours under several difficulties for being fortify'd which must be taken likewise under consideration, they are as follows.

1st. The Entrance of the Harbour is too wide to be defended from the Land, so as to prevent ships from geting in.

2d. The situation which must be chosen must occasion a great deal of extraordinary Expence which is that of cuting down the Citadel Hill and demolishing a great part of the Town.—

3d. That situation will be attended with the Disadvantage of a Hollow Way or Gulley which may facilitate an Enemys Approach.—

4th From the declivity of the Ground towards the Harbour, a considerable part of the Works will be liable to be enfiladed by Shipping.—

5th The Dock Yard lately built and at a considerable Expence cannot be surrounded by the Fortifications nor receive any Defence from them.

6th The Expence of fortifying will be very great, as Handicrafts Labour and most sorts of materials are at an exorbitant price.—

7th The Barrenness of the Land round the Harbour, must be a great hindrance to its supplying the Garrison, or any Forces that may be assembling, with proper Refreshments.—

There may be several other objections made but they are of so little Consequence that they are not worth mentioning, and these perhaps may

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be remedy'd so as not to leave reasons sufficient for giving up or laying aside so publick and so usefull an Undertaking.

The 1st Objection viz. The Wideness of the Entrance is a fault more common than is generaly imagined for there are very few ports free from it even of those that are thought so, and the best method of hindering Ships from geting in to a Harbour whose Entrance is not narrow enough to be shut up with Booms, is by mooring Hulks or floating Batterys carrying a good number of Guns, in the Channels and to prevent their laying before the place, the only method is by bringing a superior Fire upon them, and from different points if possible, and this I think very practicable here.— Objections answer'd.

The 2d. Objection viz. The Expence of cutting down the Citadel Hill and demolishing the Houses. There is no Remedy to this objection for there is no other situation upon the Harbour, that is not either commanded or at too great a distance from the Water to give the Anchoring Ground any Defence. It must be observ'd, that not only the Houses standing in the Line of the Works, but likewise all the Houses within Canon Shot of them, must be demolish'd. Some of them as I am inform'd have been built at the Proprietor's risk without any Grant and these need not be paid for, unless the Government pleases. Others which have been built by a Grant must be paid for, probably according to the Decision of Apprizers, and what the value of them may amount to, there is no judging with any Certainty, the Houses are all Wood, and many of them rotten and decay'd, consequently of little value. The Expence of removing or demolishing them will be a triffle for such as are left by the Proprietors will be carry'd off by the Soldiery and poorer Inhabitants for Firing. There must be some reasonable time given to the Proprietors of these Houses to procure other Habitations; there is room enough for them to build, and at a sufficient distance from the Works, both towards the Bason and towards Point Pleasant. The hithermost Bank of the N. W. Arm will likewise be extremely commodious for such as get their Livelyhood upon the Water.

All the Lands upon the Peninsula have already been given away to Individuals, but all upon condition of being given back when required for his Majesty's Service and receiving a reasonable allowance for the Expence of clearing the Ground. This cannot be consider'd as an Extraordinary Expence because if it had not been done, it woud be to do.—

It may perhaps be objected that the Inhabitants if removed so far from the place will not receive proper protection from it, to which it is answer'd that the Experience of latter times has exploded the Custom of fortifying places for the sake of the Inhabitants, because their Extent must generaly be such, that they are scarce ever fortify'd or garrison'd in any due proportion as they ought to be, on account of their great Expence, and very seldom hold out above a few days for that reason, and there are few situations so perfect as to admit of inclosing a great Extent of Ground without undergoing some capital disadvantage that may hasten the loss of the place when besieged, which would be the case here if the Works were extended beyond certain Bounds. And all that

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is proposed to be contain'd within this place is, such a Garrison and Arsenals as have been already mentioned, the publick offices and officers of the Government, and only as many Inhabitants as there may be room for without crowding or incommoding These, and the rest must take their chance and be contented in so good a Neighbourhood.—

The 3d Objection was that of a Hollow Way which may facilitate the Approach of an Enemy. This Hollow way is the Trough or Gulley of fresh Water River behind the Windmill Hill, express'd upon the Plan, it is considerably too deep to be filld up. and the properest thing to be done, is to keep as far from it as the Ground will allow. It is the less dangerous as this Hill is above 100 feet lower than some parts of our Works will be. There are likewise a few more Hollows but they are of little Consequence, for they may be filld at a small Expence.

The 4th objection is that the Declivity of the Ground will make a part of the Works lyable to be enfiladed by shipping. This objection may be remedied in the usual way by Traverses but it is more than probable, that ships cannot be very troublesome in this respect, untill they have silenced our Batteries towards the Water, and when that happens there will be little more for them to do. and for that reason the Anchoring Ground cannot be too well defended, nor too much Fire made to bear upon it from the Land.—

The 5th objection is that the Dockyard lately built at a great Expence, cannot come within the Works without making them too extensive and even untenable. The Ground where the Dock stands is so much seen into all round, that the power of Art cannot make it secure. These objections were made in Spring 1759, when that work was begun but were not regarded. After laying out so much money there, it may appear extravagant to throw that Dock aside, and go to the Expence of making another within the Works now designed or within reach of its Fire, if so, the most advisable thing that occurs is to build magazines for the most valuable stores within the Works, and let Masts and Timber of all sorts which may be readily replaced, if lost, remain in the Dock, as they now are, which may be inclosed with a Wall of Masonry in place of its present wooden Fence, to secure it from petty Incendiaries.

The 6th objection was the great Expence of Fortifying on account of the high prices of Handicrafts Labour and most sorts of materials. This objection is not peculiar to Halifax but must take place perhaps equaly in any other Harbour upon the Coast. The value of Labour can be reduced by employing Troops, and no other Way, both as Artificers and Labourers. There will be abundance of Difficulty to make them do enough for their money, when fixed at low wages, for notwithstanding all that officers and overseers can do, they will be so artfully lazy that with apparent diligence they will scarce do two pence worth of Work in a day. This may be remedied in Works that can be done by Task, but in such as cannot, it must and will certainly take place less or more, let officers and overseers be ever so attentive and Judicious.

With regard to materials and transporting them, it must be expected that two or three years Experience will give more insight towards procuring of them in a cheap manner, than anything that a Stranger can strike

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out with all the Intelligence he can pick up amongst the Workmen and people of the place, whose Informations are often, if not always attended with some selfish View, that conceals part of the Truth, or rather whose abilities are so confined that they must be contented with doing things as they can tho' at a disadvantage. Therefore all that is to be done at present is to give an account of what materials can be got, from whence, and at what price, which account shall be annex'd.—

The 7th and last objection was the barrenness of the Ground round Halifax to supply any considerable number of people with proper Refreshments. It is agreed that this soil is the worst upon the whole coast, but it is allow'd at the same time, that after a few years Cultivation, it will feed Cattle and yield milk and vegetables enough for any Garrison, especially during the Summer which used to be the scarcest Season, and what it cannot be supply'd with during the winter either within itself or from Lunenburg, it may have at reasonable rates from Boston and the neighbouring parts of the Continent; and when there is a practicable road opend to the back part of the Country which is very fertile and now settling, I can see no danger of the Garrison's being in any sort of want of any refreshments that are necessary. It is not pretended that the soil round Halifax is fit for Corn or ever will be, without an immense Expence, but if it had, the same ground that produced Corn, will in the neighbourhood of such a place as this must probably be in a few years, be converted much more advantageously to Grass and Gardens, for they can never feel a want of Corn in the Neighbourhood of so many Corn-Countrys.

Two Methods of fortifying Halifax.

Supposing these objections answered so as to leave no doubt about fortifying Halifax with such a Fortification as has been mentioned, fit to contain a Garrison—from 3,000 to 5,000 Men, the next thing that occurrs, is the manner of doing it which may consist of two Methods. The first is in one continued Line consisting of Bastions and Curtains with as many outworks as may be judged necessary. The second is with a Citadel upon the most commanding Ground, and the remainder to be enclosed with Bastions and Curtains &c. as in the first method or with Bastion Redoubts join'd with slight Curtains as proposed in the Report of April 1759.

Their Advantages and Disadvantages

Each of these methods has its peculiar advantage and disadvantages. The advantages of the first are, that it is less expensive, and that part of it, which takes up the Ground, where the Citadel must stand in the second Method, will consist of extensive Works that will Yield a more respectable Defence towards the Country than a Citadel can. The disadvantages of this method are, that it can be capable of little or no defence untill the whole is finished, and then the Garrison must always be strong, for if it shoud be attack'd with a weak Garrison, there is not that resource which a Citadel affords. The same advantages and disadvantages are revers'd in the second method, for the Citadel when finished, will of itself be fit to make a considerable Defence and will protect the carrying on of the other Works afterwards as conveniency will permitt, and in case of leaving the place with a small Garrison upon an Emergency. The Citadel as has been observd before, will be a great addition to their security. The Citadel has the advantage likewise of being less lyable to be surprized and of giving a good deal of Defence to the

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Harbour which the other method can not. The principal disadvantage with Regard to a Citadel, besides the Expence, is the small Extent it must have on account of the Ground which is the Defect of the Citadel proposed upon the Area of the 40 ft. Line in the Report of 1759., and this cannot be remedyd without the additional Expence of cuting the Hill a good deal lower down and destroying the two upper streets of the Town to give it a proper Esplanade.

The advantages and disadvantages of each of these methods being stated, the Choice may be the more readily determined, the sum of them is, that the first Method will be considerably the Cheapest, and with a compleat Garrison, equaly strong if not the stronger than the other. The Second Method will yield a Defence in less time and may occasionaly be trusted with a smaller Garrison, and will have a greater Command of ye Harbour.

Precautions for Planing the Works.

In planing the Works it must in general be observed for either Method, that the Poligons going up from the water to the south End of the Hill must have their Lines of Defence ranged so as to throw off the Enfilade of George's Island; and those going up to the north End, so as to throw off the Enfilade of the low Ground where the Dock stands, both these Enfilades will take place unless they are carefully avoided, and it is for this reason, that the contour of the Figure is fixd upon in the manner laid down, keeping at the same time the Command of the Ground. It must be likewise observed that the Poligons upon the Citadel Hill of the first Method, are kept considerably within the 40 ft. Line, to have the Ravelins the more Spacious; This for a Citadel cannot be done because it will augument the Fault it already has which is that of being too small.

Precautions for the Profiles.

The Profiles must vary in different parts of the Works and the Heights must be kept so as to give each part a proper Command of the Ground without and no more, so that the Counterscarp shall cover the scarp as high as possible; but if there are Casemates, this rule must be broke through, then the Ramparts must be high enough to make room for their being Bomb-proof otherwise they will be of little use, and this is a Reason why a Citadel must be very Expensive, for it must be casemated, and the Ramparts of it must consequently be rais'd higher, than those of a Simple Line, not but Casemates will be of great use in all Fortifications, for it is a Defect to want them, but Citadels in particular never ought to be without them.

The Parapets above the Cordon I think will be best of Sod, it is easiest repair'd and least hurtfull in time of service, and for the more convenient repairing of it, the Sod-work may be kept three or four feet within the Cordon which will leave room for Fascine-work clear of the Masonry for a new facing.

LINE TO the Water.

Its Advantages.

The Line towards the Water has a Ditch, counterscarp places of Arms and a Glacis before it, contrary to the usual Method, the advantages of which are, that the place is the less liable to be insulted or surprized from the Water and the Parapets are so covered with the Counterscarp that the fire of Shipping can have but a small Effect upon them in proportion to those that are exposed from top to Bottom as Sea Batteries Commonly are.

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There are peer-Heads run out for the conveniency of shipping for loading and unloading stores and there may be a very good Careening Wharf where ships of any Burthen may be careen'd.

It is allow'd that some share of the strength of a Fortification must depend upon the goodness of Workmanship and Materials; good Workmanship may with proper care be procured any where, but the Materials are commonly taken as the place affords them, and the best or cheapest made choice of according to the consequence of the place. The different Materials used for the Facing or Revetment of a Fortification are, Sod, Timber, Brick or Stone. The Facing is that part which of all others requires most Firmness and Duration, and while that stands good, any other want may be easily remedy'd. Each of these Materials have their advantages and Inconveniencies.

Materials for Revetments or Facings.

Sod is chosen either for cheapness or want of other materials, but it is of short duration especially in Countrys where the Frosts are violent and of long continuance; and it is in all Countrys the most lyable to surprizes.

Sod. Its Disadvantages

Timber is chosen in woody Countrys for Cheapness and Dispatch, in which respect it answers at first, but in the End, I think none lyable to greater disadvantages. When the Timber rots which commonly happens in twelve or fifteen years at farthest, the whole drops, probably about the same time, and perhaps when its Services are most wanted, and the Expence of repairing it then, is to a trifle equal to the first Cost, for it cannot be done properly without taking down the whole almost as low as the Foundation, so that after a period of forty or fifty years, it will probably cost more than if it had been built of the most durable materials at first, and all subsequent Repairs become a dead Loss; Annapolis in its present condition is a proof of this Assertion. It may be farther observ'd that Timber Revetments are easier demolishd by Howitzers than any other, and may suffer by Fire.

Timber. Its Disadvantages

Notwithstanding these objections to Sod and Timber, it is not meant that the use of them shall be intirely excluded, on the contrary, for some certain parts of the Work, they may be made use of with advantage, for Sod-work is by all means the properest in Parapets above the Cordon for the reasons mentioned on page 16th, and even that is as much as can be compleated at Halifax, where most part of the ground has been so lately cleared, that very little sod has as yet acquired a sufficient texture for purposes of that kind.

Sod & Timber proper for particular parts.

Timber may very safely be used in retaining Walls within the Works and sunk parts of the Counterscarp as are to be rais'd to a small Height. Timber with dry stone, must likewise be used in the Counterscarp along the Water and in the Peer-heads, where its Decay will be of less dangerous Consequence and may be easier repaired; for it would be a very great Expence to do this Work in Brick or Stone as they must be laid in Terrass.

BRICK-WORK is of Shorter Duration than Masonry and much more Expensive, it is therefore seldom used where stone can be got, but for some uses it is absolutely necessary, such as Fire-places and Partitions in dwelling-Houses, Arches of powder-magazines, Casemates and other subterraneans that are to be used for dry stores or occasionaly for lodging places.

Brick-work necessary for particular uses.—

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Masonry preferable to all other Materials.

From what has been said of these materials, it is obvious that Masonry must be recommended for the Facings of the Works, for tho' it will at first be very expensive, yet as the place is supposed to be intended for duration, it must in the End answer both for ecconomy and service far beyond any other; it must be observed, that from the long severe Frosts

Disadvantage attending it how to be remedied.—

of this Climate, Masonry is apt to suffer in a few years, unless it is properly taken care of; this is to be done by building it with as little Slope as possible, and rough casting it every three or four years, especialy the parts most exposed to the north and west; it has likewise been a practice, to cover it with a casing of thin Boards, but the other method is probably more effectual and less expensive; a few years Experience must shew which is preferable. One most necessary Precaution is, to begin and end the Works, so as to let the Mortar dry, without leting the Frost get in to it.

Everything that occurrs worth observing upon this subject, being now mentioned, the Description of the Harbours, and the account of Materials promised in pages 4th and 11th shall be inserted.

A DESCRIPTION of the Harbours upon the east Coast of NOVA SCOTIA from the GUT OF CANSO to the HARBOUR OF FOURCHU shewing the number of large ships that each may contain by Thomas Fryar Pilot.

Large Ships.

GUT OF CANSO 200

Entrance easy and wide at both Ends. Anchoring very good all along from ten to twenty Fath's. water, but the Currents are strong.

Remarks—There is Plaster of Paris in the Straits of the Gut on Breton-Island side.

CANSO, MILFORD OR CHEDABUCTO 40

Entrance difficult. Anchoring very good in the Bay and likewise in the Harbour when well known.

ISAAC'S HARBOUR ... ... 7 or 8

Entrance rocky but deep. Anchoring good within.

WHITE-HEAD HARBOUR 100

Entrance very rocky. Anchoring good when well known and the Harbour very well shelter'd.

TORBAY—Open to the Sea, full of Shoals and Rocks and very wild.

COUNTRY HARBOUR 200

Entrance rocky. Anchoring good in 10 Fath's. water but the ground is somewhat foul and must be well known; this Harbour runs a good way up the Country.

LISSCOMB HARBOUR 70

Entrance a mile wide. Anchoring good in between 8 and 10 Fath's. water.

Remarks—Starboard side going in, is high Land, the Larboard is low Land there is none of the Land clear'd.

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Large Ships.

Beaver Harbour—Not fit for Ships to go in but good anchoring without.

Popes Harbour 60

Entrance is half a mile wide. Anchoring very good in between 7 and 8 Fath's. water. The Ground muddy.

Remarks—The east side of the Entrance is a high head of white Rocks, the other side low Islands.

Tangier—Not fit for Ships.

Owls Head— Do.

Great Jedore—For a 20 Gun Ship only.

Remarks—Little Jedore in the neighbourhood is excellent Land and was well settled.

Halifax ... ... 400 or 500

Entrance easie when known and is half a mile wide in the narrowest part. Anchoring very good and well shelter'd.

Remarks—This is reckond the best Harbour and the worst Land on all the Coast.

Margaret's Bay 200

Anchoring good in 7 Fath's. water and in all weathers and good holding Ground. Entrance four miles wide, and bold—from side to side.

Remarks—The Land round is very good but none cleard, the Timber is good.

Mahon Bay—Not fit for large ships.

Lunenburg or Malisgash—Not fit for ships above 20 Guns.

La Heve ... ... 30 or 40

Entrance easie. Anchoring very good.

Remarks—good Land all round.

Port Medway or Maltois—Not fit for shipping.

Remarks—Good Land round it.

Port Senior or Ressignol—Not fit for shipping.

Remarks—The Land round is good.

Port Mutton—Not fit for shipping.

Port Hebere or Port Aux Ours—Do.

Port Roseway or Port Razior 100

Entrance very good. Anchoring very good in between 8 and 9 Fath's. Water.

Remarks—The Land round of a moderate Height and very good—No Settlements.

Cape Negro or Rabadousse 100

Entrance good. Anchoring good in 5 Fath's. Water.

Remarks—The best part of the Harbour is high up. The Lands round are good and of a Moderate Height. No Settlements.

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PORT LA TOUR	Not fit for Ships.
CAPE SABLE East passage	
CAPE SABLE West passage	
PUGNICO	
FOURCHU	

Prices of Materials and Workmanship at Halifax in Nova Scotia at the Beginning of the present War—

CARPENTERS MATERIALS.

	Halifax Currency £	Sh	D
TIMBER Fir, Pine or Spruce from 9 In. Scantling and upwards per Ton of 40 ft. Cub.	0	15	0
TIMBER Ranging from 6½ to 9½ In. scantling per Cd. ft. runing	0	15	0
TIMBER Joisting of 4 by 4½ Inches Scantling per Cd. feet runing	0	4	6
Clap Boards ... ... per M	3	0	0
Boards ... ... ft.-Supr. „	1	18	0
Shingles ... ... „	0	12	0
N.B. That Ton Timber of Fir Pine or Spruce is now sold from 18 to 22 shillings per Ton, and Oak Timber from 50 sh. to £3.			
CARPENTER per Diem	0	4	0
Do Apprentice	0	2	0

MASON'S OR BRICKLAYER'S MATERIALS.

Rubble stone walling laid in Mortar one foot high and two feet thick per Rod running...	0	12	6
N.B. The same Quantity of Work costs at present 29 Sh.—			
Laying Bricks in Walling ... ...per M	1	0	0
Do in Chimneys... ... ...per Do	1	5	0
Do in Funnels of 2 stories ... ...per Do	2	0	0
Do Arches of Magazines ... ...per Do	3	12	0
Lathing & Plaistering with two coats ... per yd. Supr.	0	2	2
Bricks Standard at a Wharf ... ...per M	1	16	0
Do New England ... ...per Do	1	0	0
N.B. The Bricks are in general very bad, & those of New England are very short of the Standard			
Lime ... ... per Hhd. of 10 Bush.	1	8	0
N.B. Lime is now above 30 Sh. per Hhd.			
Sand ... ... per Hhd	0	2	6
Laths ... ... per M	0	8	0
Hair ... ... per Bush	0	2	0
Mason or Bricklayer ... ... per Diem	0	5	0
Do Apprentice ... . Do	0	2	6
Labourer ... ... Do	0	2	6

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SMITH'S WORK is never below 5d. per lb. for rough forged Work and is often sold for 6d & 7d. filed Work and Screw Work runs from 15d to 30d

		Halifax Currency £	Sh	D
Painting	Outside with two coats ... per Yd.	0	0	7
	Inside sizing Priming & finishing ... per Yd. Supr.	0	0	10
Glazing	Squares of 8 & 10 ... ... per Sqr	0	0	4½
	Setting & Putty	0	0	2½
	Per Single Sqr Glass & Setting	0	0	10
Wateridge	Lighters of 18 Tons ... Per Diem	0	7	6
	Do of 10 Do	0	5	0
	Stones for Masons landed at Wharf ... Per Ton	0	2	0
	Do round for filling in ... Per Do	0	1	6

CARTING.

	To the Parade £	Sh	D	Upper Street £	Sh	D	Citadel Hill £	Sh	D
Boards ... ... per M	0	3	0	—	3	9	—	5	—
Tun Timber per Tun	—	1	8	—	2	—	—	2	6
Shingles ... ... per M	—	—	4	—	—	5	—	—	7
Clap Boards ... per M	—	1	8	—	2	—	—	2	6
Load of other Materils ...	—	2	—	—	2	6	—	3	—

N.B. The proportion of Halifax Currency to Sterling, reckoning the Dollar at 4Sh. 8d is, as 15 to 14, that is, £15 Halifax Currency, is equal to £14 Sterling.

Upon comparing the foregoing prices with those commonly given in England, it will be found, that Timber excepted, they are in general, about Cent per Cent higher, and Lime in particular above 500 per Cent. The only practicable method of reducing them, has been pointed out in page 10, viz. by employing Troops, and this is to be understood only for Workmen's Wages, and the Materials that are to be had upon the Spot or in the Neighbourhood, such as Timber in all its articles, Stone, Sand, and Clay for Bricks; but as to foreign Articles that must come from Europe or the Continent, the only method for reducing them is by having them from the first hand.

Iron & Iron Work to be got from Europe. —

By these Articles I mean Iron and Iron Work of all sorts, Tools included, Glass, Paint, and Lead, & to get them, at the best hand, I believe they must be got from Europe, for most of those that are to be got in this country come from thence, and are sold at a high rate.

Lime.

With regard to Lime, if it is got from the Continent, it cannot probably fall much in its Price, and for this reason, there ought to be no Experiment left untry'd to get it nearer at hand, & the Sea Coast of the Province ought to be search'd narrowly from Bay Verte to Cape Sable, and if it is not to be found there, it must be got from Spanish River in the Island of Cape Breton, or from St. John's River in the Bay of Fundi, the former of which I believe is the readiest Navigation, if we keep that Country.

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With regard to the Articles that are to be found at Halifax & in its neighbourhood, I shall only say a few words, as the Engineers to be employd there will probably after a short Experience, discover more than I have hitherto been able to learn.

Stone.— The stone hitherto chiefly used came from Chebucto Head, which is both Slatey and metalick. There is another kind at Cape Sambro', resembling the Moor Stone in England that seems to be much better in all Respects, it is very hard, and must Last for Ages; this makes it difficult to work; but there will be no occasion to work more of it than is necessary for the Cordon Angles & Gateways; The rest of the Work may be done in rough rubble of this Stone for two or three feet of the outside, and of the best of the common Stone for the inner side and Counterforts. The common Stone that seemd to me the best, is on the west side of the narrows towards the Town, there is likewise a tolerable good Vein that runs through Doctor Breynton's Field; there is enough of it to be found sufficiently good for that Purpose, without going out of the Harbour.

If it is thought necessary to have free stone for any particular use, there is enough to be got in several parts of the Bay of Fundy and from the Island of Cape Breton, opposite to the Isle just au Corps.

Sand.— There is neither Pit nor River-sand at Halifax in any quantity so that they have hitherto been obliged to use Sea-Sand. This is to be found both coarse and fine, in the north east passage & in several places. It has been proposed to gather magazines of it heap'd up in a commodious manner so as to let it receive a Year's rain and snow, to wash the Salt out before it is used, which must certainly improve it, for outside Work especially. I've been informed of a small vein of sand which runs through the Governor's Garden & Padock, about three feet broad and as much in depth, this might be open'd with little trouble for the Experiment's sake.

Clay.— Clay for making Bricks will become a very necessary Article and is to be found in several places, particularly in Cornwallis's Island, where there were Bricks formerly made, and about Fort-Sackville. There is likewise a Vein of very pure Clay found at Chester last Winter, which is said to be of a finer and better kind than is Common.

Timber.— The greatest part of the sizeable good Timber about Halifax, is now almost run out, or so far from the Water that they often prefer going to Lunenburg, Chester and along that Coast to supply their Demands. Chester-Timber of all sorts, is reckon'd the best in the Country. There still remains about Halifax, a good deal of Hemlock, and small Timber the former of which is reckond best for wharfing and rough Works, and the latter will be very necessary for scaffolding & other little occasional Uses. It is to be observed that Timber is much the more Durable for being fell'd in the Fall of the year when the Sap is down, at which Season there ought to be a Number of Men appropriated for that Business.

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REVIEWS.

GERMAN OFFICIAL ACCOUNT OF THE WAR IN SOUTH AFRICA.—Vol. II. March, 1900, to September, 1900.

(15s. John Murray).

The second part of this valuable contribution to military literature has been translated by Colonel Herbert Du Cane, and the volume in no way falls behind its predecessor which was translated by Colonel Waters.

The account covers two distinct periods and phases of the South African Campaign. In the western theatre of operations, under Roberts, it tells the story from the defeat of Cronjé at Paardeberg to the surrender of Pretoria. On the eastern side it carries Buller's Natal Campaign from Colenso to the Relief of Ladysmith. The further combined advance to Koomati Poort is lightly touched on.

While not wishing presumptuously to criticise the conclusions arrived at and the lessons inculcated by the "thinking department" of the Great General Staff of Germany, one cannot help noticing the predominance of their application to European warfare, and that sometimes not sufficient allowances are made for the peculiar geographical conditions of the country and the character and organization of the Boers.

Criticising Lord Roberts' strategy the authors say:—"His plans for Poplar Grove were typical of future actions, and consisted solely in threatening the enemy's flanks or rear and thus, while avoiding bloody but crushing blows, compelling him to evacuate his positions; to push him back was sufficient. The occupation of the country and of the towns, not the destruction of the living hostile forces, became the objective of the operations, and manœuvres took the place of battles. Weighty reasons must certainly have decided a general like Lord Roberts to adopt this mode of warfare in such exceptional circumstances; reasons connected with the difficulty of maintaining the army at its proper strength, the peculiarities of the Boers, and the great extent of the theatre of war must have specially influenced him. It is, however, difficult to justify it when viewed from the standpoint of European warfare."

The last sentence breathes the spirit of the criticism throughout the book; and we cannot help feeling that it would have been more interesting and instructive if the staff had told the German war student how the campaign could have and ought to have been prosecuted, and how it

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would have been prosecuted had the Germans and not the English had the management of it.

Probably the authors consider that, as the German student is not likely to have to fight on a large scale except in European warfare, it is not much use to dwell on the peculiarities of the South African situation, but that more may be gained by gauging everything by the standard of German methods. Keeping this idea in view we also may hope to gain from the German criticisms much that may be of value in European warfare. Reasons for strategical or tactical want of success on either side are not always given, but the actual historical facts are marshalled in such a plain, logical, and generally accurate manner that they may perhaps be said to carry their own explanations.

We gather that the German Staff considers Kelly Kenny's conduct of the action of Driefontein as worthy of all praise, in fact almost the only pattern battle of the war. "The tactics which he employed there were, however, based substantially on the same principles which the German regulations, evolved from the experiences of the campaign of 1870–1871, have laid down for the attack for a long time past." The German officer is to study this battle as an exemplification of the principles so highly esteemed in Germany. How the great staff at Berlin must have smiled when they saw Kelly Kenny one of the first of the successful South African leaders to be cast aside after the war by his unappreciative country, 'to make way for new men with new measures.'

The criticisms on Buller are firm and judicial, though couched in language of leniency and kindness. His dejection and vacillation in his communications with White are brought to notice. His conception of the Spion Kop operations is thus pithily summarized:—"He divided his troops into two portions of unequal strength, and placed the stronger, to which was entrusted the principal task, under the command of his subordinate, Warren, while he contented himself with the *rôle* of a spectator." . . . "It could therefore hardly fail to result that the enterprise was moulded by Warren's independently-formed decisions into grooves in which Buller's train of thought ran but ill. If he wanted to avoid this result he should, from the very beginning, have given orders precisely determining what Warren was to do, with details as to time and place, or he should have taken the direction into his own hands. He would not make up his mind to that, but tried subsequently, by somewhat unfortunate interference, to acquire an influence over the course of events; it was hardly to be expected that this would serve any good purpose." Here we have the essence of the cause of failure.

The tactics of Vaalkranz call forth the by no means severely-worded remark that:—"The practicability of Buller's plan must from the very first appear open to doubt by reason of the *terrain*." . . . "If the Boers occupied Doornkloof and the heights surrounding Vaalkranz on the north and east in good time, the Vaalkranz operations were altogether devoid of purpose or prospects."

The extraordinary reluctance of the commander of the Natal Army to push home victory and reap the fruits of success is pointed out in a few words, in the case of Vaalkranz on 5th February, at Cingolo on the 17th,

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at Green Hill on the 18th, and finally after the crowning success at Pieter's Hill on the 27th. The terribly false tactical situation in which the Natal Army was placed on the left bank of the Tugela on the 21st to 25th February, and the false economy practised by both Buller and Roberts in trying to gain decisive victories without suffering losses, are all pointed out clearly but calmly.

It is pleasant to see that the animus against England, which was shown during the war by the German press, finds no echo in the judgments and criticisms of their military leaders.

The historical accuracy of the accounts of the operations comes out in strong contrast to the unreliability of the majority of publications that have hitherto been produced; many of the latter seem to have been written as indictments of or apologies for certain persons or measures, and are therefore bound to be unreliable.

The "Tactical Retrospect" at the end of the book is chiefly a dissertation on the failure of the British to realize that fire action, fire effect, and the combined employment and mutual dependence of the two fire-producing arms, the artillery and infantry, are now, more than ever, the essence of war. It emphasizes the opinion that manœuvring was wrongly substituted for fighting and the maxim forgotten that success is best attained by the destruction of the live force of the enemy. "No matter what may be the nature of the country, no enveloping movement can be effective and decisive unless made in combination with an energetic frontal attack, and a flank attack should always arrive at its destination when the enemy is thoroughly occupied with what is proceeding in his front."

Individual marksmanship, clear appreciation by each man of the task before him, and self-reliance are the lessons to be learnt from the Boer riflemen. "Only those men in the ranks who can think and act on their own initiative will be able to extract the full value from the employment of their weapon. . . . Fortunate is the army whose ranks, released from the burden of dead forms, are controlled by natural, untrammelled, quickening common sense."

We shall wait eagerly to see what the German Staff will have to say in its next volume about the conduct of the later or guerilla phase of the war and the blockhouse system. No instructive work has yet appeared on this subject.

And now for a few words of adverse criticism. The least satisfactory feature of the volume is the maps. The hill shading leaves much to be desired; it is confused and smudgy and does not give a proper representation of the nature of the country or of the relative tactical values of the hill features. The sketch of the Spion Kop heights depicts the Brighton Downs rather than the rugged scarps of the Drakensberg.

Photographs do not represent the 'human' value of slopes and hills, and are generally misleading for tactical pictures.

When will publishers recognize that for the comfort and convenience of the reader maps should be bound and folded with their lower edges level with the bottom of the pages, and not with the top edges of both coinciding? This is mere common sense.

G. H. SIM.

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THE SALAMANCA CAMPAIGN.

By CAPT. A. H. MARINDIN, BLACK WATCH.—(7s. 6d. H. Rees, Ltd., London).

This book contains a carefully compiled and well-arranged analysis of the tactical movements which led to the Battle of Salamanca, in which the French Army under Marshal Marmont was defeated by Lord Wellington on 22nd July in the Peninsular Campaign of 1812.

It is evidently intended for the use of officers preparing for examination in this particular subject; the author disclaims all attempt at detail, and states that his intention is to provide merely the framework which the student can fill in from the narratives of Napier and others. For this modest purpose the author is to be congratulated on performing his task well, and his book will doubtless supply a want by affording to many a means of "getting up" a sufficient knowledge of their subject without the necessity of analysing for themselves and noting the salient points and tactical deductions which the systematic study of standard authorities should supply.

Whether a compilation which may be thus used to facilitate "cramming" for any particular examination possesses any permanent value is another matter, and one worthy of a passing notice. However good an author's intentions may be, his readers are not bound by them, and in an age in which short cuts to all branches of knowledge abound there will always be found students, who for a special purpose will welcome such aid as this book affords, without serious reflection as to the amount of knowledge of the subject which they will afterwards retain as a guide in their future professional career.

The evils of indiscriminate cramming have only very recently been emphasised by General Sir John French in a speech in which he pleaded for more solid co-operation between civil and military institutions in advancing the serious education of the British officer. The study of military history is no exception in this respect. On correct deductions from and appreciations of the tactical successes and failures of past campaigns may depend the lives of soldiers and the honour of the flag. The junior officer of to-day becomes in due course the general of some years hence, and it is well therefore not to trust entirely to any one work, however excellent, which affords easy steps to any branch of this important subject.

The book itself is a handsome and well-printed volume, though rather unwieldy in size (royal quarto) and better suited for the desk than the armchair.

The text, printed on one side of the sheets only and with generous margins, affords ample space for notes or sketches, and is interleaved with an abundance of excellent maps. These include four copies of a map of the Peninsula (scale, 90 miles to 1 inch) and eleven prints of a map of Salamanca and the country north and east (scale 6½ miles to 1 inch) showing clearly the successive movements and positions of the opposing forces during the whole of their manœuvres. As the author himself

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points out the latter maps have the great defect of not showing any hill features, and the absence of these and of the forests south-east of Salamanca, which played an important part in the struggle, greatly detract from their value for tactical study. The names on these maps and those mentioned in the text do not always agree in spelling: (Deuro—Douro, etc.). Two large scale maps, from a special survey made by Major Mitchell after the action, show the stages of the final battle and give a good idea of the features of the ground and the dispositions of the troops.

The campaign of 1812 is well worth studying as it was destined to be the turning point of Wellington's fortunes in the Peninsula.

After a patient struggle of two years against superior forces of the enemy in Portugal, as well as against the indifference of the Home Government and the inertia and incapacity of his Spanish allies, he recognised the advent of a favourable opportunity for an advance across the frontier, and promptly seized on it. Securing his communications with the sea and to the south by the captures of Ciudad Rodrigo and Badajos in the early part of the year, Wellington skilfully made a movement on interior lines between strong hostile forces, on either flank, which if united might easily have crushed him; and crossing the Agueda he reached Salamanca on the 17th June.

Although greatly outnumbering the forces of the Allies, the French armies were kept from co-operation by the mutual jealousies of their commanders and by their insubordinate disregard of the orders of Napoleon, who, occupied with his advance on Moscow, was already beginning to feel the drain of the "Spanish ulcer," which, in concert with the snows of Russia, was destined to liberate Europe and to send its conqueror as a fugitive to Elba.

Their uncertainty as to the ultimate objective of Wellington's advance was also a potent factor in keeping the French Marshals apart; and thus it happened that a total French force of 230,000 men was unable to check, except for a few months, the advance of 60,000 Allies under Wellington and their eventual victorious march through the Pyrenees into France.

On reaching Salamanca Wellington found the army of Marmont occupying three forts on the west with the main body in a strong position to the east of the city.

Laying siege to the forts, which held out for some time, Wellington placed his forces between Marmont and the city, and the two armies stood facing each other, neither apparently willing to force on a general action.

Marmont, who expected reinforcements from Caffarelli's Division in the north, retained his position until the forts were about to fall, without however taking any steps to relieve them, and then retired towards the Douro.

Wellington, having taken the forts, promptly followed him, and then commenced the remarkable series of marches and countermarches to the Douro and back, in which these two masters of tactics, with nearly equal forces, strove to outflank and outmarch each other.

The several steps in these interesting tactical movements are well brought out by the author and are illustrated by a number of maps showing the daily positions of both forces.

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These manœuvres resulted in Wellington again taking up a position at Salamanca to guard his communications with Ciudad Rodrigo, which were threatened by Marmont who was marching round him to a strong position south of the city.

The Allied forces could thus retreat no further, and Wellington, seeing a general engagement to be imminent, arranged his forces *en potence*, his left thrown back on Salamanca and the right on his line of retreat to Portugal.

The battle was commenced in the afternoon of the 22nd July by a struggle for two rocky hills in the centre of the field, called the Arapiles, the northern being captured and held by the English and the southern by the French.

The action was decided in a short time by the too great eagerness of the French Marshal to advance to his left flank before his whole force was in position, thus leaving a gap which gave Wellington the opportunity for the great counter-attack from his right for which the battle is celebrated.

The French centre was thus broken and thrown back by the Allied cavalry, and a general advance taking place, the enemy were everywhere repulsed and put to flight. They were closely pursued and driven across the Douro, and on the 12th August Wellington entered Madrid.

Described by a French officer as the "beating of 40,000 men in 40 minutes" the battle of Salamanca affords a specially interesting subject for study, as it was the first decisive victory gained by the Allies in the Peninsula.

The author concludes with notes of the several points in the tactics of both forces which have called forth much criticism in the past and will no doubt continue to do so in the future.

The earnest student is here afforded much scope for ingenuity and research in clothing the dry bones of an analysis with the picturesque details of Napier and other historians and in working out his own solutions of the problems.

Whether Marmont should have relieved the forts at Salamanca; why neither commander offered to attack the other in the first instance; why Wellington did not attack the French as they were crossing the river at Tordesillas; why Marmont in the battle advanced his left so far, and what would have been the result had he not been wounded—are all points that are worth discussing and forming an opinion on.

Should it be objected that Wellington, when he first met Marmont, showed overmuch caution, it must be remembered that, with the exception of 12,000 men under Hill who were watching Soult in Andalusia, he had with him all his available force; that he was dependent on his communications with his sea base for reinforcements and supplies; that his intention was to advance still further from that base; and that he was opposed by the most able and energetic of the French generals.

Napoleon laid down the rule, though he did not always observe it, that no general should attack unless he foresaw 70 per cent. of the chances of victory in his favour, and Wellington may well be excused under the circumstances if he declined taking any uncertain risks.

W. R. PURCHAS.

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NOTICES OF MAGAZINES.

Journal of the Royal United Service Institution.

March, 1906.

Field Fortification in the Light of Modern Warfare.—A lecture by Bt. Lt.-Col. G. M. Heath, D.S.O., R.E.—It is an axiom that the *object* of field fortifications is, by strengthening the ground and thus economizing the numbers of the defenders, to increase the force available for offensive movements; the men thus economized may be used for offensive action many miles away from the defended position. Such fortifications permit of strategical action, as, for instance, when a commander, who is numerically inferior to his opponent, utilizes a portion of his troops to hold one of the hostile columns while he throws an overwhelming force on the remainder. Tactically, field fortifications are useful only for purely passive defence and the material protection given to the men in the trenches; for counter-attacks on the defended ground close to a position are seldom likely to be decisive.

As regards *siting* the first requisites for the engineer are a good eye for ground and a knowledge of fire effect. The former can only be cultivated by practice out of doors. The practised eye will at once recognize the strong and weak points of a position, and a thorough knowledge of fire effect—the art of obtaining the best possible results from guns and rifles—will enable the engineer to put his defences in the proper place. For decisive action the best site for a trench is where the best fire effect will be obtained; this effect—provided you can see your enemy—results from 'grazing' fire, which in many parts of South Africa, India, and Manchuria can be best obtained by occupying the level ground at the foot of hills. The trench should be sited so as to procure a great depth of dangerous space for the attacker, 500 or 600 yards if possible.

To meet the objection as to difficulties of withdrawing from such forward positions, Colonel Heath says 'Do without; in an action you really mean to fight out, you do not want to withdraw; any reliefs necessary can be carried out at night.' In the absence of communicating trenches or other cover for the same purpose, reinforcing will be impossible wherever the trench is, unless against all rules it is on the sky line, or unless it is on a rear crest (sometimes the most favourable position). Supporting troops can of course be placed above the main fighting line, but they themselves must also be in good fire positions.

A great disadvantage of a trench high up is the facility which it affords to the enemy for covering his attacking infantry with artillery fire until they are close up to the position. Generally speaking too much importance is attached to high ground; as a whole a position need only be high enough to enable the defender to see the enemy's movements while screening his own.

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Invisibility is fairly easy to obtain by careful siting and screening, the latter art being particularly worthy of study. Trees and bushes are often better left standing; for instance, in the Kentish orchards one can often obtain a good field of fire under the branches while at the same time being screened by them from artillery fire.

Preparatory bombardments, unaccompanied by any coincident infantry attack, are simply waste of ammunition against properly entrenched positions. The correct use of attacking artillery is to cover their infantry as far as possible up to the position to be assaulted.

Natural obstacles on *flanks* are often illusory, *e.g.*, the sea at Nan-Shan. In nearly all cases flanks must be protected by men in suitably placed trenches or by a mobile reserve.

When time admits the preparation of a *second position* to cover a possible retreat should not be neglected.

As regards *head cover*, since the object of the artillery fire of the attack is to keep down the heads of the defending infantry while the attacking infantry is advancing, the main object of trenches should be to allow the defenders to use their rifles with good effect in comparative safety whilst under this artillery fire. Therefore over-head cover, or at least head cover, should be provided whenever possible. One sheet of corrugated iron, at a slope of 1 in 4 downwards from the line of fire, is practically proof against howitzer shrapnel; a thickness of two sheets is absolutely safe.

In arranging details the offensive power of the rifle should never be sacrificed for protection. With this in mind *loopholes* are best made in long shallow slits. The proper way of testing a loophole for minimum size is to pull out the bolt of the rifle and look through the barrel; it is not sufficient to look over the sights.

Obstacles are useful at all times, but especially against night attacks. They must be under the close fire of the defenders, that is within 100 yards; for they are little use at a greater distance than a man can see at night. If the principle is accepted that counter-attack will not take place on the ground immediately in front of the trenches, obstacles may be in a continuous line. Land mines were much used in the late war in the Far East, but they appear to have had little real effect against the attack.

The *illumination* of the foreground at night is very important. Search lights, properly worked so as not to show up your own side, are probably best. For the attackers search or other lights can be rendered ineffective by smoke screens, except in a high wind; bags stuffed with straw are effective for this purpose.

The *assault of trenches* in front and by day can only be carried out by the attackers producing such a heavy covering fire at decisive ranges that the defenders, if not actually driven out, are paralysed. Covering troops should, if possible, entrench themselves, and can then remain in forward positions for a long period. This entrenching should be carried out at every successive advance.

Portable bullet-proof *shields* may be carried up to positions occupied by covering troops and afford some protection until a trench can be dug; but their weight (8 lbs. per square foot) will render their employment very limited.

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Tools for serious work must consist of separate pick and shovel, and to be serviceable must unavoidably be somewhat heavy. Portable (light) and combined tools are unsatisfactory. When not likely to be required tools can be carried in carts or on mules, but in action these may be destroyed or may not be where wanted; therefore all infantry going into action must be provided with a proportion of tools and these they must carry on their persons.*

The principles of field fortification, both in attack and in defence, were well exemplified at the battle of Shu-shan-pu, south of Liao-yang, where the position, though only 4½ miles long, was strengthened by every device known to modern engineers. The trenches, 4′ 6″ deep, narrow, and assimilated to the natural ground, were in two tiers, one high up though well below the sky line, the other low down to give full effect to the flat trajectory of the rifle. Covered ways led to splinter-proofs cut into the reverse side of the hills. The whole front was cleared for fire, and all the actual approaches were closed by obstacles. The guns were skilfully masked, and trusted to indirect fire. On the right a high hill was used as an observatory, and was connected by telephone to the batteries. A light railway ran from the rear of the position to Liao-yang.

This position was assaulted three times without success, and the Russians then evacuated it for some reason unknown. The Japanese Sappers, in clearing obstacles on the left flank prior to the last assault, lost 75 per cent. of their numbers in 8 minutes.

In conclusion the lecturer referred to the necessity for a closer touch between engineers and other arms, not only in defence works, but in simple forms of bridging, camp arrangements, water supply, etc. Various speakers in the subsequent discussion also testified to the importance of such co-operation. Lieut.-General E. P. Leach, V.C., C.V.O., C.B., R.E., urged that the field training of Infantry Battalions should be carried out simultaneously with that of Engineer Field Companies, and mentioned recent instances of such combined work in Ireland. Colonel H. W. Smith-Rewse, C.V.O., R.E., gave evidence of co-operation in the Eastern Command. The chairman, Major-General Sir Reginald C. Hart, V.C., K.C.B., K.C.V.O., R.E., said it was the earnest desire of the Engineers to come into closer touch with the other arms.

General Hart also reminded the audience that it is an error to look upon field fortifications as a *substitute* for men. Decisive victory cannot be expected from mere passive resistance, though the ultimate object may be furthered by defensive action, as instanced by the Lines of Torres Vedras. Field works must be subservient to the troops and not the troops to the works. The only way to ensure proper tactical relations is to choose the ground most suitable to the troops and then see how field fortifications can be made to improve it.

As regards the attack, the Japanese might have avoided some severe checks and the loss of many lives if they had more often resorted to deliberate attack. Night assaults are of doubtful utility; the best plan is to get as close as possible by night, then entrench, and attack by daylight, when everyone can see what he is doing and the covering troops and guns can keep down the fire of the defenders.

* A very light tool for work in the attack, backed up by heavy picks and shovels on pack animals or in carts, may be a possible solution of the difficulty.

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PRIZE ESSAYS.—The prize and commended essays of the Special Military Essay Competition—"The best, least irksome, and least costly method of securing the male able-bodied youth of this country for service in the Regular or Auxiliary Forces as existing, and for expanding those forces in time of war"—and of the usual Gold Medal Essay Competition for 1905—"In the event of war with one or more naval Powers, how should the Regular Forces be assisted by the Auxiliary Forces and the People of the Kingdom?"—have been published in two separate pamphlets, price 1s. net each, and can be obtained from C. Gilbert-Wood, Granville House, Arundel Street, Strand, W.C.

A. T. MOORE.

NATURE.

March, 1906.

THE SYSTEM OF THE STARS.—By Agnes M. Clerke; second edition (p. 507).—This work is so good that every student of astronomical physics should be familiar with it; it has been revised so completely that scarcely a page of it remains the same as in the original edition published fifteen years ago. In this period much new work has been accomplished; the number of known nebulæ has increased from 8,000 to 120,000; the discovery of terrestrial helium has led to the recognition of a new stellar type, having helium rays prominent in their spectra; numerous stars have been proved by the spectroscope to be close couples, one in six being so constituted. From spectroscopic observations it has been possible to determine that the solar system is moving towards an apex in right ascension 277° 30′ and declination +20° at the rate of 12½ miles a second, the probable error of the result being less than one mile a second. The motion of nebulæ in the line of sight shows that there is no difference, in this respect, between nebulæ and stars and has thus removed a difficulty offered to the view, that stars arise from a condensation of nebulous matter. Finally the large number of variable stars found in certain globular clusters, the phenomena presented by such temporary stars as Nova Aurigæ and Nova Persei, and the structure and distribution of nebulæ in the Milky Way, can only be simply and sufficiently explained by the existence in space of clouds of obscure particles, alone or associated with luminous matter, demonstrating that space may include as much dark material as bright.

Until a few years ago, nebulæ were believed to be masses of glowing gas at a high temperature, but the author is now able to write that they are not excessively hot bodies, being luminous through electrical excitement; gaseous nebulæ are, in fact, reasonably believed to be at a temperature not much above absolute zero; they are not, then, incandescent but rather luminescent, their light is independent of thermal conditions. The tendency of all nebulæ to assume spiral forms demonstrates, in itself, their close affinity, though some do not give the characteristic spectrum of hydrogen and helium.

Electric and thermal effects cannot be distinguished from one another;

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stars having the smallest number of chemical elements represented in their spectra are probably the hottest, while an increased number of lines in other spectra is probably due to the existence of an increased number of chemical elements as the result of lower temperatures, the inferior position in the temperature scale being indicated also by the reduction of the relative length of the spectrum, increase of the relative intensity of red radiation and general absence of enhanced lines. No writer on astronomy has a more facile pen than Miss Clerke, and the amount of reading and careful analysis involved in the preparation of this work must have been very great.

W. E. WARRAND.

RAILWAY GAZETTE.

February 23rd, 1906.

LARGE LOCO. BOILERS.—By G. J. Churchward.—This is an exceedingly interesting paper, illustrated by a number of diagrams of recent designs. It is astonishing to see the variations in the amount of heating surface provided. Wide fireboxes, hitherto little introduced in this country, seem particularly prone to tube troubles, mainly no doubt because the mass of the fire is so much nearer the tube plate, the depth of the box being reduced so as to get a pair of trailing wheels under it. The wide box burns poor coal with facility and economy; but waste occurs if the engine is kept standing much, because the grate area is so large.

With the high pressures now used the problem of water circulation and the keeping up of a flow of water to the tube plate has been increased in difficulty; and the precise arrangement of the tubes, so as to leave ample room for the feed of water down the spaces of the firebox, is of great importance. Experiments have shown, however, that the exact direction of circulation may be entirely changed by altered firing.

Experience of long tubes has been quite satisfactory, and if the diameter is not too great they enable the boiler to be forced without bad effect.

After all the main noticeable point in present-day designs is the recognition of the fact that plenty of boiler power is more likely to solve the working problem than increased size of cylinders.

TREATMENT OF GOODS TRAFFIC: TRANSHIPPING.—The establishment of a central Transhipping Shed at Crewe on the L.N.W.R. seems to have been a marked success. Stations which cannot make up through loads send their consignments to Crewe, whence they are forwarded in loads combined so as to save haulage. The effect is generally to substitute one transhipment and a two days transit in the case of small lots for a number of transhipments with corresponding delays and damages.

In connection with the transhipping a system of bonus payment of men according to the amount of goods handled has answered very well.

Of course the geographical situation of Crewe is the essential feature in the scheme.

March 2nd, 1906.

OPERATION OF ELECTRIC RAILWAYS DURING A SNOWSTORM.—Experiments on the New York Central Railway to ascertain the most satisfactory

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arrangement of the conductor rail. There were about 13 inches of snow between the rails at the time.

Various arrangements of unprotected, hooded (rail upright), and hooded (rail inverted) third rails were compared. The inverted or under-running rail was found to give much the most satisfactory results, in all other arrangements trouble being experienced through the formation of ice.

RAILWAY EDUCATION.—Proposals for a College to improve on the haphazard methods by which railway business must be learnt. Of course, in America there are Colleges for most things, from advertisement writing to locomotive firing (this last by correspondence).

The list of "Subjects of the Curriculum" is however interesting, particularly perhaps to R.E. officers who have to do with railway matters. It comprises:—railway Construction, Maintenance of Way, Economic Theory of railway Location, railway Terminals, Plans and Specifications of railway structures of all kinds, railway Accounting, Station Returns, the construction and use of railway Statistics, Organization, handling of Traffic (Freight and Passenger), Signalling and Train Service, Motive Power equipment, Car equipment, Ratemaking, Government Control of railways, Passenger Department, Freight Department, railway Finance, Telegraphy, Corporation Law in its relation to railways, Railway Liability. Law of Carriers.

C. E. VICKERS.

RIVISTA DI ARTIGLIERIA E GENIO.

February, 1906.

THE BATTLE OF MUKDEN.—Capitano d'Artiglierio Giannitrapani contributes an excellent description, illustrated with photographs and with maps on a scale of 1:168,000.

According to the most reliable information obtainable the complete list of the losses sustained by the Russians during the entire period of the battle, viz., between the 21st February and the 11th March, amounted to 96,500 men. This figure is indeed enormous, and if our calculations have a foundation of truth it amounts to about one-third of the effective forces engaged. The losses are subdivided in the official documents as follows:—

Officers	Killed and prisoners	...	645
	Wounded and sick...	...	1,812
	Total	...	2,457
Men	Killed ...	...	14,000
	Wounded	...	56,000
	Sick ...	...	5,000
	Prisoners	...	19,000
	Total	...	94,000

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The total of prisoners, which is considerably less than in the exaggerated list published shortly after the battle, includes about 2,000 sick and wounded who were found in hospital at Mukden.

Thus the Russians left about 17,000 men in the hands of the enemy, and of this total about 15,000 were made prisoners on the 10th and 11th March, but especially on the 10th, from the rear guards of the 2nd and 3rd Army Corps.

The captures of war material made by the Japanese were less important. Thanks to the early removal of their heavy artillery only 58 pieces of field artillery were lost by the Russians. The large magazines for provisions and forage around Mukden were as far as was possible destroyed by fire. According to official reports the Japanese captured at Mukden 60,000 rifles, 150 ammunition carriages, 200,000 artillery projectiles, 25 millions of cartridges, 2,000 horses, 23 carriages with topographical maps, 1,000 carriages containing clothing, and a large quantity of railway material for the field railways.

Regarding the losses of the Japanese a complete list is not yet known, nor their distribution. The list given amounts to 41,000 men, and represents about one-eighth of the forces engaged at the commencement of the battle. In comparing the losses sustained by the two combatants it is necessary to bear in mind that the Russians appear always to have maintained the strength of their units during the battle, replacing the gaps from time to time with troops moved forwards from the regimental depôts which were in the theatre of war.

When we compare the losses suffered by the Russians at Mukden with those sustained in former battles of anything approaching the same scale, we become convinced that although Mukden may exceed the registers of history in the numbers engaged, in the extension of the fronts, and in duration, it certainly does not exceed them in actual losses. At Sedan the French losses—only during the battle—amounted to about one-third of the effectives; and that battle was decided in a few hours, whilst the combats around Mukden lasted 18 days.

An examination of these lists confirms previous notions regarding the number of losses by death and wounds in modern battles in contrast with the always increasing efficiency of cannon and rifles. Tactics are changed contemporaneously with armaments. The objects of the changes are to mitigate the effect of exposure to an enemy's weapons by appropriate formations, by utilization of the cover offered by the ground, by the avoidance of frontal attacks as far as possible, and by the systematic use of field fortifications.

The series of military operations which have passed into history under the name of the Battle of Mukden affords copious information of every kind; and although documents and particulars are still wanting, the history of the battle will present for a long time a profound tactical and technical study. Besides its military result in placing the enemy's army out of action for some time and delivering a great territory, the battle was of great political importance. For nearly all the yellow races it consecrated the defeat of Russian influence in Asia; and for the Chinese, the capture of Mukden, the holy city, the cradle of its dynasty, was a deliverance from a barbarous invasion.

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On the 20th March Marshal Oyama, after a triumphal march through Mukden, handed over the city to the Chinese magistrates; and by this act of rare courtesy showed that the Japanese were equally valiant warriors and able politicians.

TO THE NORTH POLE BY DIRIGIBLE BALLOON.—The idea of reaching the North Pole by balloon, which seemed to have been abandoned after the unfortunate issue of the André expedition, has now been renewed by the American explorer and journalist Wellman.

Mr. Wellman is known in connection with two Arctic expeditions, carried out by ordinary methods, which were fertile in noteworthy results. He passed two summers and one winter in the 80th parallel of north latitude and in 1899 succeeded in reaching the 82nd parallel. Well acquainted with the meteorology and climatic conditions of the boreal regions, and with matters of importance for the enterprise, he communicated his ideas to the *Chicago Record Herald* and to a group of American gentlemen with a taste for scientific questions.

In its main lines Wellman's project may be stated thus: to travel in the ordinary way *viâ* Spitzbergen and Valden Island to a point as near as possible to the North Pole, between the 80th and 81st degrees of latitude; and thence to endeavour to reach the Pole in an automobile balloon. The distance to be travelled in the balloon, going and returning, will be about 2,000 km. In event of its being found impossible for the balloon to reach so far, an automobile sledge will be used.

The principal dimensions of the balloon are in the proportion of 1 to 3, that is 16 mètres in diameter and 48 mètres in length. It will have a volume of about 6,000 cubic mètres, and will carry five persons in the car:—a pilot, a mechanician, a doctor in charge of scientific observations, a sailor, and Wellman himself.

Taking into consideration the atmospheric conditions likely to occur in July and August (the time at which the exploration would be made) and supposing the temperature to be from – 37°F. to + 37° F., the height of the clouds being from 400 to 500 mètres, the explorer intends to travel at a low altitude and consequently renounces the idea of great velocity. He would perhaps attain a velocity of 25 km. an hour with a 50 H.P. motor. In the event of this motor or the screw becoming out of order, he would be able to make use of an auxiliary motor of 25 H.P. and a small screw. The two motors and the two screws could be worked at the same time, by which means it may be possible to attain a velocity of 30 km.

Mr. Wellman's idea is to have everything ready by June, and to find himself at this time at his base of operations where he also intends to instal a station of wireless telegraphy. If the preliminary trials regarding the dirigibility and the management of the apparatus should be successful he would undertake his journey towards the Pole during this summer; otherwise, profiting by the experience acquired, he would work at the necessary modifications during the winter and postpone the expedition to the following year.

E. T. THACKERAY.

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CORRESPONDENCE.

ORGANIZATION OF R.E. UNITS FOR EMPLOYMENT WITH CAVALRY.

DEAR SIR,

In my article on the above subject in the February number of the *R.E. Journal* there are two misprints which I should like to correct.

(1). The title of the photo should read "Tool Wagon" instead of "Double Tool Cart." The vehicle consists of a limber and a wagon, and it does not split into singles.

(2). On page 86, in the summary for a Squadron, R.E., the "Horses, Riding," should read 10, 6, and 48 instead of 10, 8, and 66.

On reconsideration I have to suggest that each Troop should have 2 more riding horses, namely 1 for the S. & C. Smith (Farrier) and 1 for a Draught Branch N.C.O., so as to have the Troop intact with 24 horses, or 3 Sections of 8, which would admit of a Section being detached as such for work with each Cavalry Regiment of the Brigade (see first para. of page 87).

This alteration would give a 'Higher Establishment' Squadron 58 riding horses for the rank and file and a 'Lower Establishment' one 32, and would produce a total under that head in the last para. of the article of 122 "Horses, Riding."

Yours sincerely,

C. DE W. CROOKSHANK,

Capt., R.E.

Pretoria, 25. 2. 06.

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RECENT PUBLICATIONS.

With Mounted Infantry in Tibet, by Bt. Major W. J. Ottley, 34th (Sikh) Pioneers. ($8\frac{1}{2} \times 5\frac{1}{2}$. 10s. 6d. Smith, Elder).

The Battle of Mukden. Translated from a *Beiheft zum Militär Wochenblatt*, by Karl von Donat, late German Army, with "Comments on the Battle" by Lieut.-General von Caemmerer. Maps and Orders of Battle, etc. (8 × 5. 6s. Hugh Rees).

Sechs Monate beim japanischen Feldheer, von Major v. Schellendorf. (8vo. 10 mks. Berlin).

The Real Triumph of Japan, by L. L. Seaman, M.D. ($7\frac{1}{2} \times 5$. 6s. Appleton).

Les Enseignements Maritimes de la Guerre Russo-Japanese, par J. L. de Lanessan. (Félix Alcan, Paris).

A History of Tactics, by Capt. H. M. Johnstone, late R.E. ($10 \times 7\frac{1}{2}$. 15s. Rees).

An Epitomized History of the Militia, compiled by Colonel G. J. Hay, C.B., C.M.G. ($9\frac{1}{2} \times 6$. 10s. 6d. United Service Gazette).

Napoleon, Moltke, und die Festung, von Oberstleut. Frobenius. (8vo. 1.25 mks. Berlin).

The Arbiter in Council. A Symposium on War, Peace, and Arbitration. (8vo. 10s. Macmillan).

L'Armée Allemande au 1er Janvier, 1906; *son Organization, ses Tendances, son Ordre de Bataille.* (8vo. 1.25 frs. Paris).

Report of the Indian Survey Committee, 1904–05. Official. (Folio, with separate vol. of evidence. Simla).

Constructional Steelwork. Notes on the Practical Aspect and Principles of Design, with an account of the Present Methods and Tools of Manufacture, by A. W. Farnsworth. (10s. 6d. Griffin).

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Our Waterways. A History of Inland Navigation, by W. A. Forbes and W. H. R. Ashford. ($9 \times 5\frac{1}{2}$. 12s. Murray).

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Technical Dictionary in Six Languages. English, French, German, Italian, Spanish, Russian. Vol. I. Machine Elements. By K. Deinhardt and A. Schlomann. ($7 \times 4\frac{1}{2}$. 5s. Constable).

A Complete Pronouncing Gazetteer or Geographical Dictionary of the World. Edited by A. and L. Heilprin. ($11 \times 7\frac{1}{2}$. 42s. Lippincott).

Things Indian, by W. Crooke. (12s. Murray).

Lord Curzon in India. Being a selection from his speeches as Viceroy, 1898—1905. With explanatory notes by Sir Thomas Raleigh, K.C.S.I. (9×6. 12s. Macmillan).

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March, 1906. L. J. GRANT, Sec., Sen. Acad.

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*Read partly at the Army College, Aldershot.

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WOOLWICH, DECEMBER, 1905.

THE FOLLOWING PASSED DIRECT FROM US:—

SECOND	H. G. MacGEORGE	7,196
FOURTH	G. WALTON	7,046
FIFTH	H. A. COX	6,967
16th	R. CROFTON	6,330
45th	D. STEPHENSON	5,899
54th	J. KENNEDY	5,711

SANDHURST, DECEMBER, 1905.

THE FOLLOWING PASSED DIRECT FROM US:—

SEVENTH	L. H. CRIPPS	5,144
46th	M. E. C. JOSEPH	4,336
58th	A. G. D. O'FLYNN	4,215
59th	P. J. R. WIGLEY	4,212
61st	G. C. I. HERVEY	4,187

ARMY QUALIFYING (SEPTEMBER), FOUR.

PROMOTION.

More than EIGHTY Officers who read with us PASSED (*d*) in MAY LAST.

Work for both "C" and "D" is now going on.

Militia Military Competitive, March and September, 1905.

FOURTEEN PASSED.

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U. C. L. DUPLICATE

THE ROYAL ENGINEERS JOURNAL.

Vol. III. No. 6. JUNE, 1906.

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MILITARY COLLEGE, RICHMOND, SURREY.

(Inspected by the University of London).

MR. H. F. TRIPPEL and MR. SPENCER MITCHELL

PREPARE FOR ALL ARMY EXAMINATIONS AT

Onslow Hall, Richmond Green, & Shrewsbury House, Twickenham Park

Town Branch—

10, Duke Street, St. James's, S.W.

SUCCESSES JANUARY, 1904, TO JANUARY, 1906.

WOOLWICH.

Place.	Name.	Place.	Name.
8th	C. Holland.	43rd	S. M. Noakes.
*15th	H. Smithson.	46th	V. A. H. Taylor.
18th	C. H. Lemmon.	50th	H. G. Worsley.
*19th	W. E. Buckingham.	*56th	B. F. Rhodes.

SANDHURST.

6th	G. H. MacCaw.	32nd	A. E. Saunderson.
11th	A. G. Saulez.	39th	H. A. Studdy.
*15th	G. I. Carmichael.	66th	H. K. D. Evans.
23rd	R. H. Koster.	131st	R. G. Moody-Ward.
*25th	H. F. Slattery.	148th	G. T. Wright.
30th	J. S. Hicks.	151st	D. M. King.
K.I.C.	A. F. Prendergast.		

INDIAN POLICE.

2nd ... ... W. T. Wickham.

ARMY QUALIFYING CERTIFICATES.

Name.	ROYAL ARTILLERY. Regiment.
F. G. J. Berkeley	The Yorkshire R.G.A.
A. F. A. Hooper	The Duke of Edinburgh's R.G.A.
G. B. Bosanquet	3rd Bn. The Suffolk Regt.
E. L. Salier	4th Bn. Shropshire Light Infantry.
C. K. Apthorpe	4th Bn. South Wales Borderers.

CAVALRY OR INFANTRY.

W. C. Wilson	6th Bn. Royal Warwickshire Regt.
K. P. Wallis	Royal Monmouthshire R.E.
G. F. Bowes-Lyon	4th Bn. Argyll and Sutherland Highlanders
G. H. Westbury	3rd Bn. Royal Berkshire Regt.
E. S. Bamford	3rd Bn. Leicestershire Regt.
G. M. Wright	3rd Bn. Royal Munster Fusiliers.
T. H. O. Crawley	7th Bn. Royal Fusiliers.
W. F. Anderson	7th Bn. Royal Fusiliers.
L. F. Hepworth	4th Bn. East Surrey Regt.
W. Grischotti	S.E. of Scotland R.G.A.
S. O. Robinson	5th Bn. Middlesex Regt.
E. F. Robinson	3rd Bn. Shropshire Light Infantry.
*H. H. Clarke	3rd Bn. Royal Welsh Fusiliers.

* Successful under the New Army Regulations.

MILITIA COMPETITIVE.

Place.	Name.	Place.	Name.
3rd University ...	G. K. Archibald.	39th Infantry ...	L. F. Hepworth.
4th University ...	H. Wilson.	49th Infantry ...	W. Grischotti.
6th Infantry ...	G. F. Bowes-Lyon.	51st Infantry ...	J. T. Hibbert.
12th Infantry ...	J. Mallinson.	59th Infantry ..	T. F. V. Forster.
13th Infantry ...	C. K. Apthorpe.	W.I.R.	C. F. Hughes.
18th Infantry ...	S. H. Drummond.	W.I.R.	F. J. Stevens.

PROMOTION.

Over ONE HUNDRED and NINETY OFFICERS were assisted in "C" and "D."

STAFF COLLEGE, AUGUST, 1905.

ONE Officer received a nomination, and SEVEN qualified.

Telegrams—Trippel, Richmond, Surrey. Telephones—72 and 341 P.O. Richmond, and 884 Mayfair.

NOTE.—Mr. Trippel or Mr. Mitchell can be seen at 10, Duke Street, St. James's, S.W., between the hours of two and five.

N.B.—Special Terms for Sons of Officers of the Royal Engineers.

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FOURTH SERIES.—VOL. I., 1905.

PAPER	I.	**Simple Tunnel Work on the Mari-Attock Railway, Panjab,** by Capt. H. E. C. Cowie, D.S.O., R.E.	1s.
,,	II.	**Long Span Bridges,** by Max am Ende, M. Inst. C.E.	1s. 6d.
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8	yards	at 3,000	,,
20	,,	5,000	,,
85	,,	10,000	,,

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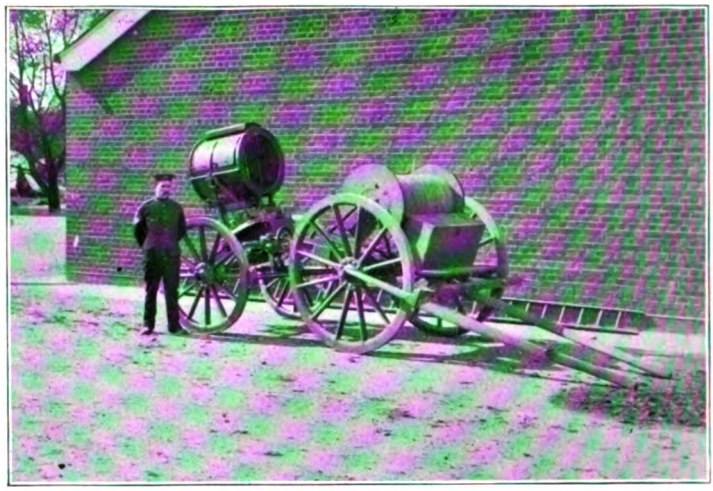
FIELD SEARCH LIGHT EQUIPMENT.



24 inch Projector on Trail Carriage,
with concentric cable on converted gun limber.

24 inch Projector on 14 cwt. R.C.D. Wagon,
with cable on special axle in rear.

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AN ARMY ENGINEER INTELLIGENCE BUREAU.

By 'G.'

Two previous contributions to these columns—Major A. T. Moore's in the number for December, 1905, and Capt. G. Walker's in that for March of this year—both contained a suggestion that merits further discussion, namely the proposal for an Engineer Intelligence Bureau.

We must all fully realize the necessity for such an institution. The Intelligence service of the Army is organized in geographical sections; its primary duty is to collate information on the organization, equipment, and training of foreign armies; and its officers are selected irrespective of the various branches of our Service. Consequently its sphere is largely confined to purely military subjects, and comparatively little notice is taken of scientific details which may have a military application. No doubt a certain amount of engineering and other technical matters are dealt with, but the collection of information on such matters does not appear to be definitely arranged for. Moreover, the sources from which such information is obtained are not always trustworthy, and it requires technical knowledge to test its reliability and judge of its importance. Furthermore, there is no medium for the circulation of the really useful residuum amongst those for whose benefit it is presumably collected.

The reasons for all this may be sought in the fact that under the existing system the majority of those employed in collecting intelligence are necessarily lacking in technical knowledge. The Army as a whole is not fully appreciative of the importance of contemporary engineering science in relation to warlike operations, though we have progressed considerably in this respect of recent years. As a nation, moreover, we are too insular in our ideas, too much given to rely on the old hammer-and-tongs methods, too little inclined to profit from technical advances in the sphere of civil life.

We as a Corps, with our multitudinous interests and most varied

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duties, in which improvements are constantly taking place, suffer more than can be described in a short paper by the absence of a Central Intelligence Office. As individuals we find it almost impossible to keep abreast of the times as regards the changes and progress of engineer-technical matters, not only in foreign armies but also within our own organization. Employed as we are in all parts of the world on all sorts of work, often carried out without its very existence being known to more than a few on the spot, there must be an appreciable waste of time and mental effort through officers working out designs *de novo* instead of being able to start at a later stage with the knowledge and experience previously gained by others in similar concerns.

So much for the necessity for an Engineer Intelligence Bureau as a means of economizing time and labour, and therefore probably money also, and of keeping the Corps in a high state of education and therefore of efficiency.

As to the scope of the proposed Bureau, this is a more difficult question. If the organization is to be complete, the sphere of its operations must indeed be large ; and it must comprise all branches of science, not only military ones (such as artillery, small arms, permanent and field fortification) but also the more purely civil branches (such as metallurgy, steel and iron manufactures, railway work, bridge construction, electricity, telegraphy and telephony, aeronautics, etc., etc.). In short the Bureau must be the central organization, whereby the Military Engineers of this country first of all, and also their colleagues in the other branches of the Service, may be put in possession of any sort of scientific knowledge bearing upon their work.

In initiating such a Bureau it would possibly be wise at first to confine its investigations as to civil methods to English-speaking countries. Military information pure and simple, however, would have to be sought throughout the world. It may be as well to point out here a malady which we Englishmen are very liable to suffer from : We are too apt to look on at the work of other nations with a sort of benevolent condescension and say to ourselves "that has no application to us, we are an island power, we have a navy" and so on *ad infinitum*. We suffer from a sort of sloth in this respect. If we do not see any direct application to ourselves in any foreign method, we cast it aside as unworthy of investigation ; quite forgetting that, although we may never have to use the method in question, we may possibly have to counteract it, and that in this sense the more knowledge we have of it the better.

This is a digression ; we must now consider a definite proposal for action. It has been said that an appreciation of any military situation without a definite proposal for action would be like Macaulay's bee without a sting or a horse without legs.

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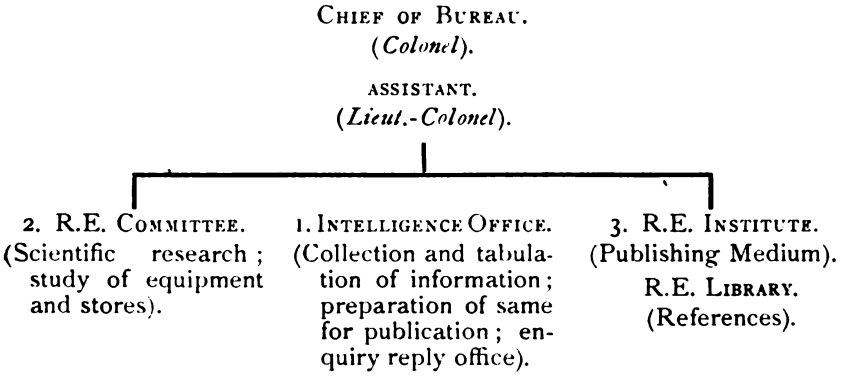
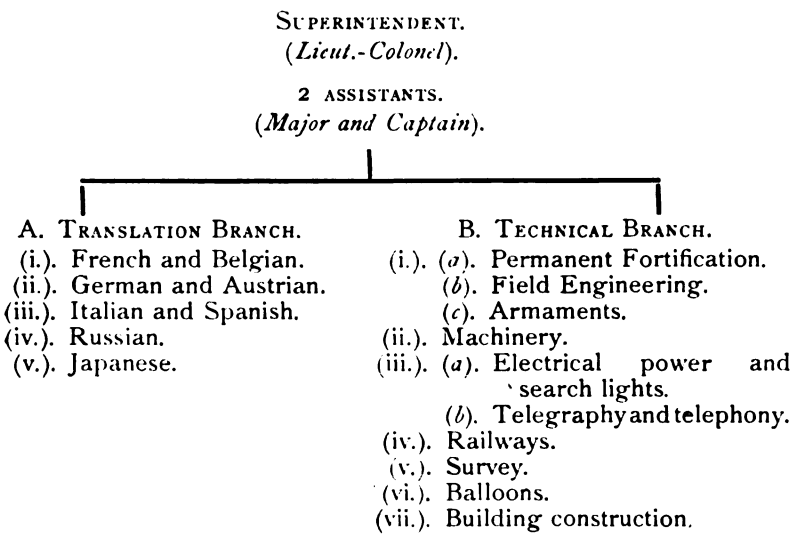
We therefore submit the following diagram as a definite suggestion for the organization of the proposed Bureau.



The Intelligence Office might be organized as follows:—



The duty of the Translation Branch would be to search for information and pass lists of the same to the Technical Branch; the latter, after personal communication with the former, would sift the information, obtaining translations when necessary, and forward the useful residue to the Superintendent. The Superintendent would pass this on to the Chief with a view to publication. One of the Assistant Superintendents would act as the medium between the two branches. The other might act as recording officer; he would thus be in a position to reply to any technical enquiry from any officer in the Corps, and to give at once either the actual information sought after or else a reference as to where it could be obtained; it would

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probably be convenient for the R.E. Headquarter Library to be in his charge.

Each of the sections enumerated under A and B Branches should have an officer in charge, and it would be desirable to have two for B (i.). The officers selected for B Branch should be experts in their own line, and should not be below the rank of captain. They should be appointed for not less than five years, for continuity of policy is necessary; changes must be carefully weighed by men of experience, and frequent changes in personnel usually mean kaleidoscopic and therefore often harmful changes in policy. The B Branch officers would also carry out collating work in their own subjects so far as concerns all English-speaking countries. In addition their duties would include the acquiring of information from officers employed on any special work in their own line and the preparation of communications to the Corps at large.

The officers in A Branch might be of any rank, and might even be retired officers. The linguistic staff may appear large, but it is essential to the success of the scheme that the Bureau should be in *constant* touch with foreign progress and ideas.

The R.E. Committee already exists, and might remain as now constituted. It has been suggested that certain of the officers in B Branch might form this committee, but such a course seems undesirable. The Committee is an advisory committee to the War Office for the adoption of inventions and equipment in the British service; its deliberations and recommendations are often of a confidential nature; but we should avoid anything secretive in the Intelligence Office, which is intended to be mainly educational.

The R.E. Institute also already exists as a publishing medium; and could take its place in the proposed scheme with but little change.

The Chief of the Bureau might be *ex-officio* President of the R.E. Committee and Chairman of the Institute Committee. It would be necessary for him to be a senior officer of scientific attainments, as he would have to decide questions of considerable technical intricacy; he should also possess in addition a good all-round knowledge of the varied duties of the Corps. In order that his decisions and advice might have a solid foundation he should be empowered to send his officers on tours of inspection to visit works of all descriptions. Like the President of the Ordnance Committee he might be a retired officer.

There remains the question of cost. But a detailed consideration of this would be premature until a settlement of the most efficient organization of the proposed Bureau. Several of the officers could be retired officers so that their cost would not be heavy. The establishment of clerks and draftsmen would be very small; this also might consist mostly of reservists or pensioners, but in B Branch they

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would have to be selected men of high technical knowledge. The only large item of expense would be the printing of communications to the Corps; but a subsidy for this purpose as in some of the European armies would surely be justifiable.

Whatever the cost—in reason—, if the proposed Bureau tended to the increased efficiency of the Corps, as it undoubtedly would, it would be money well spent; and it might even result in economy in the engineer portion of our military expenditure.

Finally, it is not suggested that this Intelligence Bureau should supersede any existing institution. Its object is to work hand in hand with those already established and to amplify their work. To do this it must be in constant communication with them and must be prepared to help them with scientific advice, and so bring about that millenium when the British Army shall be the first of all armies and the British Empire the most surely founded of all.

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a semi-circle. Draw a tangent at C. Make AD=$\frac{1}{3}$ the semi-circle, AE=$\frac{1}{4}$, and AF=$\frac{1}{5}$. Bisect the angles DBE and EBF at G and H. Draw GI and HK perpendicular to AB. Prolong AC to L, making CL=GI and CM=HK. On AL and BM describe semi-circles cutting the tangent at N and O.

Then CN is very nearly equal to the side of a cube of which the volume is double that of the cube on AB; and CO is very nearly equal to the side of a cube of which the volume is equal to the sphere of diameter AB.

For $CN^2 = AC \times CL = 2AB \times GI = 2AB^2 \sin ABG.$

But by construction

$$ABG = \frac{ABD + ABE}{2} = \frac{60^\circ + 45^\circ}{2} = 52^\circ\ 30'.$$

$$\therefore\ CN = AB \times \sqrt{2 \sin 52^\circ\ 30'} = AB \times 1{\cdot}25965.$$

Similarly $$CO^2 = AB^2 \sin ABH,$$

and, by construction,

$$ABH = \frac{ABE + ABF}{2} = \frac{45^\circ + 36^\circ}{2} = 40^\circ\ 30'.$$

$$\therefore\ CO = AB \times \sqrt{\sin 40^\circ\ 30'} = AB \times 0{\cdot}80589.$$

The value of CN as found by construction is 0·00027 less than the true value, and CO is 0·0001 less than the true value.

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TEMPERED DUCTILE METALS.

By Capt. C. H. Versturme-Bunbury, R.E.

A Mr. Z. F. Vaughn of Los Angeles in Southern California claims to have made a discovery that may have very far-reaching effects on the arts and sciences.

It appears that he has spent many years in experiments to solve the problem of tempering gold, silver, and copper; and that he has finally succeeded so far as to be able to produce instruments from these metals with a temper equal to, and with an edge more enduring than, steel.

At present the use of this discovery is confined chiefly to the manufacture of gold surgical instruments; but there is a large development probable in the production of tempered copper for journal bearings, springs, and electric supplies.

Samples of these tempered gold and copper instruments have been submitted to tests by experts in Los Angeles and are certified by these experts to be genuine gold and copper.

The following remarks are taken from the "Los Angeles Mining Review" of 17th February, 1906:—

"Mr. Vaughn began his investigations in 1888 and has been steadily at it ever since. He does not claim to have discovered a lost art, but to have invented means whereby gold, silver, and copper, either separately or in alloy, can be taken through the various degrees of crystallization which correspond to the several tempers known in the arts.

"By the process used these ductile metals are not only hardened, but their density and homogeneity are brought to such practical perfection that a cutting edge is effective because of its absolute and microscopic fineness and smoothness. It does not tear—it divides; and for surgical purposes instruments of tempered gold are said to be superior to those of steel because of this keener edge and because no microscopic speck of rust can harbour dangerous germs.

"Interesting and important as the tempering of gold is from metallurgical and surgical points of view, the great commercial value of the discovery lies in its application to copper and in the widely extended use of that metal which is thereby promised.

"It is stated by Mr. Vaughn that tempered copper is not subject to that crystallization through vibration which limits the life of steel; that springs of tempered copper have not only as great elasticity

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and strength as steel springs, but that, owing to the extreme slowness of the process of crystallization, they will retain the spring temper for a practically indefinite period; furthermore, that, owing to this quality of tempered copper and its great tensile strength, all metal parts of machinery which are subject to vibration may be more profitably and (as in the case of propeller shafts) more safely made of copper than of steel.

"It is thought that the most immediate, and possibly the most extensive, use of tempered copper will be for journal bearings. It is stated that, owing to the great density of the metal, it takes a perfect polish with use and makes an almost frictionless bearing, free from danger of overheating, and long outlasting either babbit metal or brass for the purpose.

"It is also thought by scientific men that tempered copper, owing to its hardness and density, will solve several important problems of electrical engineering with the result that usefulness of electrical machinery will be materially extended, with corresponding increase in the use of copper."

I happened to be in Los Angeles at the time when this discovery was made public and have seen some of the gold surgical instruments. They certainly appear to have all the qualities claimed for them as regards elasticity and keenness of edge. But I have not seen any of them tested as to their being in fact gold. Nor have I ascertained what would be the effect upon their temper of raising them to a high temperature; it is stated that their temper would not be affected by such treatment.

This discovery appears to be worthy of investigation and scientific testing, as, if its claims can be substantiated, it should have an important bearing on many problems connected with science and art.

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THE INFLUENCE OF RATE ON ACCURACY OF FIRE.

By Capt. D. Brady, R.E.

The following is an account of some private experiments made at Esquimalt, B.C.

It will save repetition if the meanings assigned to certain words are defined :—

Rate is the reciprocal of the whole time taken for a single shot, taking a minute as the unit of time.

Accuracy is the reciprocal of the probable error of a shot.

Probable Error is the error—measured in minutes of arc—that in a long series of shots half the shots would fall short of and half would exceed.

Intensity is the number of shots that fall on a unit area in a unit time.

Density is the number of shots on a unit area ; it is intensity multiplied by time.

Weight is the number of shots on an area ; it is the *average* density multiplied by the area, or the *average* intensity multiplied by both the area and the time.

The object of the trials was to find out how *Rate* affects *Accuracy*. Strictly, rate depends on many things that cannot directly affect accuracy ; for instance, on the time it takes to open the breech, to close it, and to bring the rifle back to its position for aiming. It would be difficult, and not very useful, to determine how much of the time taken for each shot was spent on such operations. Nothing but the time it takes to fill the magazine was excluded in the trials.

They are very incomplete, as I had to pay for them. Only three men fired, and all were good shots. Three were taken, because if only two had fired and one had some peculiarity I might have found it hard to say who it was ; good shots, because had I begun with bad or medium shots I might have ended with good ones, without knowing how to make due allowance for their improvement.

No notice was taken of *lateral* accuracy ; and to make sure that no time was wasted in trying for it, the target gave nothing to aim at but a horizontal line. On such a target correct elevation should secure a hit.

If a long line of men of equal skill fire at such a target, each man at the part opposite him, the shots will be spread uniformly *along* the line, however they may be spread vertically. In effect, it is the

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same as if each man's shots were spread along a length corresponding to the interval between firers, and none of his shots went outside.

Imagine a great number of shots fired. Some will go above, some below, and a few will hit the line. If a vertical screen were put behind the line, and every shot were arrested by it or by an already arrested shot, a sort of mountain of lead would be built up, of a section like that shown in *Fig.* 1.

Level with O, which represents an end view of the line, the section would be thickest ; above and below it would thin off, at first slowly, then more quickly, then again slowly. The thickness at every level exactly represents the probability of a shot there.

If at equal distances above and below O lines Pp Pp are drawn so as to enclose just half the area of the section, it is obvious that it is an even chance whether a shot will go between P and P or not. OP is the "probable error" of a shot.

The length OP cannot be determined with positive certainty ; how it is determined approximately will be seen later on.

Now imagine the firing repeated, for the same length of time, but at a different rate, say twice as fast. All that can be foretold with certainty is that the new section will have double the area. Whether Oo will be thicker or not depends on the new length OP. If the new OP is double the old, the new Oo will be the same as before ; if the new OP is the same as before, the new Oo will be double the old. Oo is in fact proportional to the *Rate* divided by the *probable Error*. As long as the quotient does not decrease, the intensity of fire at O will not decrease.

But even if Oo is smaller for a higher rate, the *Weight*, and therefore the *Average Intensity*, will be greater for a height DD, if D and D are only far enough above and below O (*Fig.* 2). It is not easy to directly compare the areas of the sections between D and D ; but if, instead of probability-sections, curves whose ordinates are proportional to the areas of sections for given distances from O are plotted, the difficulty disappears. These curves are shown in the lower half of *Fig.* 2.

Fig. 3 gives particulars of the probability and the probability-integral curves. In both cases 1·0 must be plotted equal to the adopted probable error. In the probability curve the ordinates must be plotted to a scale proportional to *rate* divided by *probable error*. In the probability-integral curve the ordinates are to be plotted to a scale proportional to *rate*. All curves of a class can then be read by one scale.

In the trials the level of O was assumed to be the average level of the shots, to avoid *constant* errors of rifle, sights, and holding. But as the average level changes with every shot fired it is itself subject to error. The probable error of a shot was found as follows :—The difference of level of each shot from the average was squared ;

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the sum of the squares was taken and divided by one less than the number of shots; ·6745 times the square-root of the quotient is the probable error. Of course, had the real level of O been known, the sum of the squares would have been divided by the number of shots, not by one less than that number.

Knowing the rates and their probable errors, probability and probability-integral curves could be drawn. But the probable errors were known for isolated rates only. So the rates and their probable errors were plotted as co-ordinates in *Figs.* 4*a*, 4*b*, 4*c*, and 4*d*, and smooth curves were drawn to show their continuous relation. The points given by the trials are too few and too inconsistent to let one draw these curves with any confidence; I may have drawn them wrong.

The curves show some well-known things, and for the men that fired something I did not know. They show that the probable error is never zero for any rate, however low; and that in quick firing, when nearly all the time is spent in mechanical work and little is given to aiming, the probable error grows fast. The tangents shown touch the curves at points corresponding to the rates of greatest intensity of fire at a mere line, and these rates are rather higher than I expected.

In *Figs.* 5*a*, 5*b*, and 5*c* the figured curves give the number of shots a minute, at various rates, that may be expected on targets of various vertical heights. The more curves come within the limits of a target the more shots a minute will that target get. The dotted line marked "index of best rate" indicates the closest grouping of the curves, and incidentally the rate that will give the greatest *average* intensity of fire for a given target.

These curves are constructed from *Figs.* 4 by plotting or calculating probability-integral curves for the different rates and probable errors—a simple but rather tedious business.

I hope the diagrams will in other respects explain themselves, as this account is already too long.

So far it has been assumed that accurate aiming means accurate hitting. It does, but only if the sights are properly set for the range. Otherwise the intensity is all in the wrong place. The clumsy remedy for uncertainty of range is to maintain accurate and therefore slow fire and to vary the backsight elevation. The better way is to let the fire spread itself so as to include any likely error in range-finding. In more precise words, the size of the target—measured in minutes of arc—to which the rate should be adapted is not the small vertical angle the enemy's line subtends; it is that angle *plus* twice the difference of backsight elevation due to the likely error in range.

For example, the enemy's line subtends 2 feet and the range estimate is 1,250 yards with a likely error of 50 yards either way. At 1,250 yards, about 10 feet difference of backsight elevation gives 50 yards difference in range. The *virtual* target is therefore 2′ + twice 10′ = 22′, not 2 ft. as it would have been had the exact range been known.

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Take a less simple case of spreading fire. Orders are received to search a belt 200 yards deep, of which the edges are 1,400 and 1,600 yards away. If the firer is above the plane of the belt he can measure the vertical angle it subtends; let it be 14 feet. If he is in its plane the angle is nothing. If he is below its plane the angle is negative, but he may have some indirect means of learning its amount; let it be 16 feet. These angles are the angles subtended by the target in the three cases. But the fact that the target is not all at one range has to be met. It is as if the estimated range were 1,500 yards with a likely error of 100 yards either way. For 100 yards at 1,500 yards the difference of backsight elevation is about $22\frac{1}{2}$ feet. The virtual targets are therefore $+14' + 45' = 59'$, $0' + 45' = 45'$, and $-16' + 45' = 29'$ for the three cases assumed.

To go a step further. Suppose the mark for aim is not the centre of the belt but something else. The proper backsight elevation is that for 1,500 *plus* or *minus* the vertical angle between the centre of the belt and the mark, *plus* if the mark is below, *minus* if the mark is above the centre of the belt. Let the mark be the near edge of the belt, *i.e.* 7 feet below, in line with, or 8 feet above the centre of the belt, according to the case considered. The elevations to be used are 1,531, 1,500, 1,464, though the mark for aim is 1,400 yards off.

Officers are not likely to have either time or facilities for such calculations on ordinary service. But they might find them worth while in special cases; for instance in sieges, or in fights round positions of very great importance, wherever indeed economy of ammunition is a secondary matter and economy of men and time is the first.

Of course if there is no cover, if firers must remain exposed to fire whether they are firing themselves or not, there would be no sense in using the rather high rates the diagrams indicate. The shooting of a man exhausted by over-exertion is not likely to be very useful. When there *is* cover to use for loading and for resting the best rates, the rates of fire that expose the firers for the shortest time and do most damage to the enemy can and should be used.

It is hardly polite to give my facts and then presume to draw conclusions which readers would prefer to draw unassisted; but my facts may be rather obscurely told, so it may clear up things if I say what my conclusions are.

1. Neither accuracy alone, nor speed alone, is enough.
2. Room must be made in the transport train for enough ammunition, even if fighting men are left behind to make it. Better make the fullest use of a smaller number by giving them enough ammunition, than make unnecessary targets of the rest. It is the weight of fire in the right place that counts, not the number of men.

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3. It would be better in peace field practices to limit the *times* of fire at targets, not the ammunition; so that companies might learn the best use of their rifles, not the best use of a limited allowance of ammunition.

The most effective use of other things than rifles or bigger guns might be found in a somewhat similar way.

When the time is limited and the value of something has to be found by repeated measures, the most accurate result will be got when

The *Rate* of repetition divided by the *square* of the *Probable Error* of a measure is a maximum.

It does not pay, then, to delay over each measure in the hope that it will be very accurate; the result of the series of measures may suffer.

CONDUCT OF TRIALS.

The targets were made of white paper, about 27 in. × 21 in. The mark for aim was the top edge of a broad wooden strip, red-brown in colour, along the bottom of the target. Targets.

The range was 71 ft. 8 in. from eye to target, so that an inch on the target subtended four minutes of arc very nearly. Range.

Kneeling position, no dead rests of any sort. Position.

The 700-yard sight was used, to avoid damage to the aiming mark and to avoid the use of leaf-down sights. Sights.

Eleven shots were fired at each trial, the first just off the target, the other *ten* at it. Shots.

Each man started himself. His first shot was his starting signal. Starting.

The time was taken by stop-watch from the sound of the first shot to the sound of the eleventh. It was assumed to be ten times the time of each shot on the target. Timing.

At each trial the man settled his own rate. If he repeated the same rate he was asked to avoid it in future if possible. Rate.

The rifles used were service rifles, long, all with somewhat worn barrels. The ·22 Winchester automatic used is only a toy, but it gives some idea of what the rifle of the future can do. Rifles.

I hope complete experiments will be made by someone more competent than myself; but no one could find three men more willing to make them a success than Co.-Sergt.-Major R. Orchard, Sergt. D. Godfrey, and Sergt. A. Sergeant, of the 48th Company. They must have found the firing very dull work, but they never showed it and it never spoiled their keenness.

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NIGHT OPERATIONS AT CHATHAM.

THE night operations described in the July, 1905, number of this Journal were repeated on a somewhat extended scale on the 22nd and 23rd of January last.

The 'General Idea' was that a Blue Force of 3 army corps had landed at Sheerness, the North Foreland, and Lydd; its object, after concentration being the capture of Chatham for use as a base.

The 'Special Ideas' were as follows:—*Blue.* "Sheerness has been captured and Chatham and Rochester are invested on the south and south-east. On the 6th instant the north-west edge of the wood in front of Fort X was captured by our troops; but their further advance was checked by a redoubt (about 1,200 yards from the fort) against which it was decided to commence mining operations. On the 22nd instant the galleries were completed; and arrangements were made to fire the mine at 3.30 p.m. on this date and to effect a lodgment, from which advance trenches could be pushed against the fort."

Red. "Chatham and Rochester have been invested on the south and south-east. Sheerness has been captured by the enemy, and the movable armament has fallen into his hands. In front of Fort X a semi-permanent redoubt has been constructed, and from reports of spies it is believed that an assault of this redoubt is contemplated as a preliminary step to the capture of the fort. The fort must be held to the last."

The Blue Force attacked the advanced redoubt about 3.30 p.m. on the 22nd; and it was actually blown up. During the night the attackers advanced and entrenched themselves on a line running parallel to and from 200 to 300 yards from the front of the fort. On the morning of the 23rd, the defenders were driven in from their outlying trenches, the demolition parties cut ways through the wire entanglements, and under cover of fire from guns, howitzers, machine guns, and rifles the ladder parties scaled the ditch and the fort was captured.

DEFENCE MEASURES.

The defending force was under the command of Brevet Lieut.-Colonel A. W. Roper, R.E.; and consisted of the Training Battalion, R.E., an improvised Search Light party, R.E., 1 battery of 4·7″ guns, and 1 battery of 5″ howitzers. (The guns and howitzers were represented by R.A. officers).

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Fort X is situated on a plateau ; in front and on the left flank the ground slopes slightly ; and on the right flank, commencing at about 150 yards from the ditch, there is a steep descent. The country in the neighbourhood is generally open and free from natural obstacles. The ditch is about 30 ft. wide and 20 ft. deep, with masonry escarp and counterscarp.

The troops defending the fort were divided into three sections—left flank, the fort itself and the outworks in front and on the left ; right flank, the outworks on the right ; reserve, in rear of the fort. The guns were assumed to be near the next fort on the right of Fort X, about 2,000 yards distant ; and the howitzers about 1,500 yards behind the left rear of Fort X. The fire of the latter was supposed to be directed by telephone from a high building in rear of the fort.

As regards the actual defences, the parapet of the fort itself was recessed and overhead cover was provided for every rifle. Outworks, in the shape of covered or traversed trenches, were constructed on the front and flanks of the fort, the loopholes being made so that no work could fire into another. Between these trenches was erected a girdle of wire entanglement, so aligned that each length was enfiladed by one or more of the works. As much of the foreground as time permitted was covered with fougasses and mines, represented by flares, which were fired either automatically by trip wires, or by exploders, or by wires from the works. Three electric search lights were installed, one in the fort itself, one at the end of the battery site at the edge of the steep slope on the right flank, and one some distance down this slope. Along the hedge below the bottom of the slope flares were erected in trees, in order to light up the ground not covered by the electric lights ; these flares were fired by friction tubes operated from an outwork (see sketch on accompanying *Plate*). Acetylene lights were also tried.

The amount of wire entanglement erected was limited by the amount of wire available ; in reality a much greater extent of ground would have been covered by this and other obstacles, and barbed instead of plain wire would have been employed. Had time allowed covered communications would have been provided between the detached trenches and the fort ; and more flares provided.

ATTACK MEASURES.

The attacking force was under the command of Brevet Lieut.-Colonel G. M. Heath, D.S.O., R.E. ; and consisted of detachments of three Infantry battalions, of the Marine Light Infantry, and of the Depôt and District Battalions, R.E. (totalling about 1,300 all ranks), part of a Search Light Section, R.E., 1 brigade of field artillery, and 1 battery of 6″ howitzers. (The artillery were represented by R.A. officers). Capt. C. O. Place, D.S.O., R.E., acted as C.R.E.

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The advance after the capture of the semi-permanent redoubt was made in the dark. O.C.s battalions were ordered to detail working parties for trench work under the orders of the C.R.E., who was made responsible for the reconnaissance of the enemy's position, the clearance of obstacles, and the distribution of tools and shields. Two of the battalions (less their working parties) acted as covering parties, guides being provided by the C.R.E.; and another battalion was in reserve. The C.R.E. was further instructed to facilitate operations by screens and smoke and by the use of the search lights; and to supply working parties for the C.R.A. as required. Lights, smoking and all noise were forbidden; and officers and men were ordered to lie down whenever the enemy's search light played on them, whether advancing or digging.

The actual assault on Fort X was carried out by daylight on the morning of the 23rd, the south-east face being selected as the point of attack. One battalion was detailed to assault this face, as soon as their left flank had been covered by the capture by another battalion of the outworks on the south face; a third battalion was ordered to occupy the trenches on the right, in order to enfilade the above faces of the fort and protect the right flank of the attack; the fourth battalion was held in reserve behind the left flank. Machine guns were brigaded and placed near the right flank. The C.R.A. was directed to keep down the fire of the adjacent forts during the advance, to bring as far as possible oblique fire on the faces of Fort X selected for the assault, and to co-operate in the assault by keeping up fire until the last possible moment. The howitzers were assumed to be in rear of the right flank, about 2,300 yds. from Fort X, using indirect laying; the field artillery far on the left flank, firing at a range of about 2,500 yds. on the fort to the right flank of Fort X.

The O.C. attack, who was with the reserve, was in telephonic communication with the trench from which the assault was to be delivered. The assaulting columns were organized as follows:—

First Line.	Covering party.	1 company.	At close distances.
	Demolition party.	R.E. (to remove obstacles).	
	Ladder party.	1 company with 6 ladders.	
Second Line.	Covering party.	1 company.	
	Ladder party.	1 do. with 6 ladders.	
Third Line.	Remainder of battalion in successive lines.		
Fourth Line.			

O.C.s units were shown a plan of the ground and given all information obtainable as to details of ground, nature of obstacles likely to be met with, etc. The position from which the assault was to be delivered and the right and left of the attacking parties were also indicated as far as possible. O.C.s storming columns were informed that, in face of the nature of the ground, want of cover, etc.,

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success could only be obtained by successive waves of men at close intervals advancing with the greatest resolution and regardless of losses; to ensure the arrival of ladders for crossing the ditch, several spare officers and men must be detailed to each ladder, any ladders dropped by the first lines being picked up by lines in rear; once in the ditch the storming parties would be under cover. Covering parties were instructed to bring as large a volume of fire as possible on the face selected for assault, and to keep up this fire until the last possible moment.

GENERAL REMARKS.

The defenders of the fort would have benefited by the possession of light Q.F. guns, pom-poms, and machine guns, as no final assault could have been attempted before the destruction of such small calibre armament.

When the attack lights were thrown on the fort parapet its defenders were dazzled and could not direct aimed fire at less than an angle of about 60° with the enemy's beam. Otherwise the attack lights appeared to be of more assistance to the defenders than to the attackers, as the attack beams showed up the advance of the attackers very plainly.

The attackers employed a smoke screen to cover their working parties. The smoke was made by lighting sandbags filled with straw. When blown upwards by the wind it was ineffective, but it proved a good screen when dense enough.

The attackers also used shields on wheels to protect men detailed to destroy wire entanglements. One shield was in the shape of a clockwork mouse, being propelled by an officer lying flat inside it; the other was a wheelbarrow with plates fixed round the front and sides; both forms had slits to allow of the man protruding his arms to cut wire. Both shields were sent out on the night of the 22nd; but, being unsupported by rifle fire, they were easily captured. The mouse was again sent forward next day, and the umpire ruled that the operator was successful. It is doubtful whether such shields could be of general use; in this case the ground was smooth, and Q.F. and machine guns were absent from the defence.

O.C. Attack brought to notice that the artillery with heavy guns had no means of entrenching themselves, rendering it necessary to employ other troops for this purpose.

He was kept in excellent communication with his force by telephones erected by the R.E. and by the regimental signallers. The regulation oil reading lamp was not so good as a pocket electric-light lamp which was used by the officer in charge of the telephones. The barrows used for running out the telephone were very unhandy.

The mist during the morning of the 23rd interfered appreciably with the fire of the guns on both sides.

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There was considerable confusion amongst the attacker's working parties when the covering parties were discovered by the defenders and fire opened on them.

The ladder parties did not advance on as broad a front as intended. Scaling ladders should be as light as possible, preferably of bamboo.

ELECTRIC SEARCH LIGHTS.

The following are extracts from the reports of the officers in charge of the search lights, Lieut. A. E. Davidson in the defence and Capt. R. Walker in the attack.

DEFENCE LIGHTS.

"*Position of Lights.*—Three lights were employed. Two, with 24-inch projectors were placed, one inside the fort on its left flank, and one at the end of the battery site on the edge of the escarpment beyond the right flank. The third light had an 18-inch projector, and was located below the crest of the escarpment. All these lamps had 15° diverging lenses.

The engines and dynamos were placed outside the gorge of the fort.

Control of Lights.—The two larger lights were in telephonic communication with the O.C. Defence. In the daytime certain directions for the beam were fixed and to each a letter was allotted. At night, on any letter being given, the light was traversed to the corresponding position.

The third light was out of the view of the O.C. Defence and was controlled by verbal instructions from the O.C. right flank.

Cover.—Owing to the wide arc through which the beams had to be traversed, it was not possible to provide satisfactory head cover for the men at the lamps, nor for the lamps themselves. It is suggested that for use in similar positions it would be worth while considering the question of designing a light steel bullet-proof shield, revolving round the same pivot as the lamp itself and with a narrow port or opening such as is used with the parabola ellipse projectors in coast defence.

Effect of Lights.—On account of the short time available for getting the projectors, engines, and necessary fittings into position, it was not found possible to have a trial run of the lamps before the attack commenced. Owing to this the beam from the lamp on the battery site was not particularly effective till towards the end of the attack.

One successful use of the defence lights was to shine up the beam of an attacking light and neutralize the dazzling effect of the latter.

One effect of the attack beams, which was of value to the defence, was that just sufficient light from these beams was reflected from clouds or mist on to the ground in and behind the fort to enable the defenders to find their way about.

As the attack was made over a wide front, and as there were not

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sufficient lights to illuminate the whole of the ground, the lights had to be traversed frequently from one place to another. To ensure full use being taken of opportunities thus offered of firing at targets revealed, and to allow of a sufficient number of aimed rounds being fired at a target shown up by the beam, it is necessary to have close co-operation between commanders of fire units and the operator traversing the lamp. Owing to the supply of ammunition on this occasion being limited, it was not possible to make the conditions in this respect realistic.

When the lights were first started, as darkness came on, the attacking force was comparatively close to the position, and during the rest of the attack the light was only thrown on objects at short ranges. As a result no information was gained as to the value of the lights for long range work.

No serious attack was make on the outlying works on the extreme right flank ; and the light in this section, although effective in illuminating the ground, was not called upon to light up bodies of the attacking troops."

ATTACK LIGHTS.

"The surroundings of the fort were not well adapted for attack search lights ; but were favourable for the defence lights, as they always would be, the foreground having been previously prepared. The necessity for having portable projector towers as part of the equipment was proved.

No. 1 Light, concentrated fixed beam from 60 c.m. projector.—A wooden staging, giving 17 ft. command was erected for No. 1 Light at a point distant 1,000 yds. from the right front of the fort. The intervening ground was slightly convex ; and at one point, about 300 yds. from the fort, it was noticed that (assuming the defence lights had been put out of action) trenches could have been constructed without detection with the aid of the diffused light from the beam overhead.

Disadvantages.—It is almost an impossibility, unless there is high or steep ground in the vicinity, to employ attack search lights without, at some time or other, showing up the attacking forces. This is a distinct disadvantage when the defence has no lights ; but does not matter so much when it has, or when the attack trenches are sufficiently deep to protect the men in them. The disadvantage may be overcome by constructing first those trenches that are outside the attack beam—this being kept in a fixed position—or by creating a smoke screen and digging behind it.

Illuminating Effect.—There is no doubt this light showed up the fort parapet very well and was very effective in dazzling the defenders. It is considered that with a 16° diverging lens the dazzling effect would have been just as good, while 200 yards ($\frac{1}{5}$ of range) of the fort would have been taken in and no traversing of the light necessary.

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Vulnerability.—Taking into account that the siege had been going on many days and that the defence had no guns fit for action, this light could have lived for a very long time, if not all the night through, at this range of 1,000 yds.

Use for the Assault.—Had it been decided to carry out the assault by night, this light would have been very useful in showing up the point selected for the assault and the ways cleared through the obstacles.

No. 2 Light, same as No. 1.—The other attack light was placed 600 yards to the left flank of the fort, so as to act as a screen to the entrenching parties, being directed in between them and the fort's two beams.

Owing to intervening buildings and want of command, this was practically the only position available where the attempt at screening could be made; and it was afterwards discovered that this position was within about 200 yds. from the supposed line of defence!

This light was not of very much use, however, as a screen, the defending lights being at too close a range, and the defender's view was not at all impeded.

The smoke screen, while it lasted, was much more effective; but special smoke boxes (as used in drain testing) which burn without a flame would probably be better than wet straw.

No doubt really close entrenching work could not have been executed until the defending lights had been put out of action. In such case this attack light would have been of great use, if kept in a fixed position to aid the entrenching by its diffused light and to act as a sentry beam guarding against the surprise of counter-attacks from the fort.

The Defence Lights (from Attackers' Point of View).—These lights were most useful in showing up the entrenching parties, but more lights and smaller would have been better. 12-inch projectors are effective as 16° beams within 700 yards and as 30° beams probably within 500 yds. As the last siege parallel is usually not more than 300 yds. off, small 25-ampère lights would be quite powerful enough, if so placed as to light up a given area of ground without any traversing being necessary. Moreover small lights afford smaller targets.

Uses in Siege Warfare.—Briefly the uses of search lights in siege warfare appear to be :—

A. In the Attack.

(i.). To dazzle the defence and prevent accurately aimed fire.

(ii.). To detect counter-attacks and attempts at repairing obstacles.

(iii.). To light up the points of assault and cleared ways through the obstacles.

(iv.). To assist in the destruction of obstacles and in the construction of trenches.

(v.). To assist artillery fire by night.

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B. In the Defence.

(i.). To assist rifle fire from the parapet.
(ii.). To detect all attempts at trench digging within close range.
(iii.). To assist in the defence of the obstacles.
(iv.). To guard against a surprise assault in force."

As regards the range of search lights it has been found elsewhere that, with a 60 c.m. projector and a concentrated beam, observers slightly to one side of the light could detect masses of men at 1,400 yds., skirmishers in khaki at 1,000 yds., light coloured buildings at 2,000 yds., and any large objects at 1,700 yds. Observers 2,000 yds. in front of such a light would probably see 1,000 yds. beyond the limits just mentioned. As regards width of ground illuminated, with a concentrated beam it would be 50 yds. at 1,000 yds. from the light; with a dispersed beam from a 16° lens the width is approximately $\frac{1}{5}$ the range.

Both in attack and in defence the beams should normally remain fixed; concentrated beams are the most suitable for the attack, and dispersed beams for the defence. With defence lights properly used an assault by night is rendered very difficult; and in such a case the best time for an assault would appear to be early dawn. Attack lights intelligently used act as guides for the advance and are also useful for examining obstacles or particular areas of ground; but absolute concord is essential between the O.C. Attack and the officer in charge of the search lights.

ENTRENCHING UNDER SEARCH LIGHTS.

Capt. C. O. Place remarks :—

"The methods of extending working parties as laid down in the Drill Book could hardly have been adopted under the full glare of the search light without very heavy casualties and consequent confusion. In all probability the R.E. detailed to trace the trenches would have been put out of action, in which case the trenches would probably have been dug in the wrong places and without any system.

The plan adopted was as follows :—

(*a*). The tools were issued to the various working parties under R.E. arrangements, the places of issue for different units being quite distinct so as to avoid confusion.

(*b*). Each party was under the guidance of an R.E. officer, who had already received detailed instructions concerning the work to be executed.

(*c*). On the advance being ordered the parties moved forward independently, in extended order, to the most advanced sheltered position. There they lay down, utilising all existing cover.

The R.E. officer and a sapper crept forward to choose the position where the trench was to be, the officer using his own judgment as to

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exact site. They took with them a tracing tape, divided with pieces of bunting into task lengths. This was picketed out along the required position, and then everything was ready for the working party to come up.

(*d*). The working party were sent up one by one in short rushes over the exposed ground, and on arrival each man's task was pointed out by the R.E. officer.

The men had to dig in a prone position. The large tools were very unsuited to this sort of work; and the amount of digging accomplished in this way was hardly enough to justify the hope that any one would survive long enough to produce any efficient cover.

Some men of the digging parties were provided with steel shields, 3 ft. by 1 ft. 6 in., weighing 40 lbs.; but these were heavy to carry, and not large enough to give much cover.

The working parties would have suffered great losses in real warfare unless the fire of the defence had been previously much subdued; and probably the only possible method of securing an advanced position in the face of an efficient defence is by sap."

FLARE LIGHTS.

The following are extracts from a report by Capt. F. S. Garwood, R.E., of the defending force.

" Lights may be divided into three classes.

1. *Long Range Lights.*—The only efficient ones are electric search lights. These are naturally few in number, but are unapproachable for general efficiency.

Flares set by trips can also be used, but they are uncertain and liable to be fired by the scouts of the attackers.

2. *Medium Range Lights.*

(*a*). Under control from parapet:—Flare lights fired by electricity; flare lights fired by wires to pull or cut.

(*b*). Flare lights, mechanical trip; flare lights, electrical with tread contacts.

All have the disadvantage that they can only be used once, and that they can be tampered with by the enemy's scouts. However, several mechanical flares may be arranged in series to be pulled off by a single long wire.

3. *Short Range Lights.*—Only useful up to what our ancestors called 'pistol shot.'

(*a*). Wells' Lights (oil); Acetylene Lights.

(*b*). Flare lights, fired by lengths of instantaneous fuze.

These are all certain in their action, but have a limited range.

The flares used in these operations were nearly all fired by the

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sandbag and friction tube method of ignition. All of them were protected from rain by small pieces of canvas.

The following were the results. (1) Lights worked by mechanical trip wires: one missed fire owing to tube slipping out; one wire broke on account of its being thin through rust; the remainder worked successfully, except one jack-in-the-box, which failed when wanted owing to its being improperly set, though successful before and afterwards. (2) Lights with buried firing battery and contact tread; worked successfully. (3) Lights connected up electrically with an exploder: were marked by the enemy during daylight, and wires cut before they were fired. (4) Lights fired by instantaneous fuze: worked successfully. Many of the flares were fired by spectators and umpires.

Light composition was put in all the flares, but no attempt was made to differentiate between flares proper and those representing land mines and fougasses. The means of ignition would be the same, but the two latter were out of the question in manœuvres.

The results of the flares were disappointing considering the labour expended on them. They suffered from the following disadvantages :—

(1). They were put in hand too late, when the other working parties had used up every bit of wire for entanglements and only short scraps were left.

(2). The friction tubes for ignition could only be obtained at 1 p.m. on January 22nd.

(3). Only one N.C.O. and myself knew how to set them properly, and this had to be done hurriedly in a bitterly cold wind.

(4). No flares are obtainable from the Ordnance Department, and all the composition had to be manufactured from a receipt out of Spon's *Workshop Receipts*.

(5). Crowds of spectators were wandering over the ground pulling off the trip wires.

(6). The enemy's officers and N.C.O.s reconnoitred all the arrangements at their leisure, and were able to cut all the leads of the electric circuits.

(7). The defence search lights cast the flares in the shade and gave the enemy light to cut wires.

Umpires' Criticisms.—The chief umpire with the attack said the flares were too low. They were placed as high as possible. The flare light placed up the tree had an excellent effect; the wire controlling it was 250 yards long, hung on telegraph poles and quite out of reach of the enemy's interference.

The chief umpire with the defence said the flares did not burn long enough, but there I venture to differ. In manœuvres men crowd round a flare; in war time in two minutes there would not be a man in its neighbourhood. Short-lived and frequent flares are what is required.

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General Remarks.—Setting trip wires properly is an art in itself, requiring plenty of practice. A good supply of small hooks and eyes for changing direction of trip wires is necessary.

For most cases instantaneous fuze should be painted any colour but bright orange (I had to have a pot of paint handy to paint it green). The box it is packed in could be painted red, if it is not to be stored in magazines, the fuze itself being of a similar colour to service dress.

The acetylene gas light is useless as a flare when opposed to electric lights. When the latter are not available it is useful in bridge repairs or issuing stores, or any work where a good light is required by night.

Hastily improvised flares, where only an hour or two is available for preparation, are bound to be unsatisfactory. There are always so many men and animals in the neighbourhood of camps that trip wires are more dangerous to friends than to the enemy and should be prohibited. In savage warfare, where the enemy are known to be addicted to sniping and firing into camp, the flare light arrangements should be in the hands of a special detachment. Trip wires should be fitted with a hook-and-eye connection so that they may be rolled up out of the way and quickly set when wanted.

When several days are available for the defence of a position the wires for flares and land mines should either be buried in piping, or carried as aerial lines on trees and telegraph poles. If electrical apparatus is not available, the sandbag and friction tube method will be found just as effective, but should not be used for land mines. The sandbag can be suspended from a safety line, the cutting of which sets off the light. The friction tube must be firmly secured to the wood by at least four 2″ nails. The sandbag should be connected to the eye of the tube by a strong piece of wire. There should be a gap of about an inch between the mouth of the tube and the strands of quickmatch which ignite the instantaneous fuze. Flare light composition can easily be made by mixing four parts nitre, one part sulphur, and one part mealed powder."

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*NOTES ON ENGINEER DUTIES IN GARRISON.**

By CAPT. A. M. HENNIKER, R.E.

MANY officers look upon Division Work as uninteresting. When a man tells you that Bridge is uninteresting you may be sure that he is not a first-class player, and you will probably find that he has not played enough to appreciate its problems or learnt how to solve them. It is the same with Division work. No other branch of R.E. work is really so varied or brings one in touch with so many different professions, trades, arts, and sciences.

It is hoped that the following pages may be of some assistance to officers taking up Division work for the first time, and perhaps suggest some new ideas to those already employed thereon.

If you take any garrison and add up all the people who live in barracks—including in the total not only men who figure in a Church Parade state, but all the women and children, all the civilian subordinates, barrack labourers, canteen attendants, and so on—the population will rarely amount to less than that of a respectable village, and will sometimes equal that of a small country town. In many cases the barracks form a thickly populated ward or district of a town. A large proportion of the subjects which engage the attention of Municipal Authorities—the laying out and maintenance of new roads, street improvements, street lighting, water supply, sewerage and storm-water drainage, fire prevention, what in municipal affairs is known as the "housing of the working classes," and many others—require just as much care and forethought in barracks. And the man whose business it is to look after these things, planning out new works, extending, altering and improving existing things, is the Division Officer. Repairs and maintenance are no doubt important parts of his work, but in a well-ordered Division they are more or less matters of routine. He is the man to consider whether altered circumstances have necessitated a new road; whether his barrack roads are lit as well as those of the town; whether his married quarters are up to the standard of modern requirements; whether the barracks are adequately protected from fire, and all such questions.

An actual example will perhaps show best the sort of work referred to. Fifty years ago a single block of married quarters was planted

* Lecture delivered at the Royal Engineers Institute on 11th January, 1906.

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on a piece of waste ground. It has since grown into a compact village of over 400 inhabitants, housed in 7 blocks, with a large laundry and numerous outhouses, forming 100 separate quarters. Until recently 40 of the quarters consisted of a single room with no water laid on. In some cases the nearest place for the disposal of waste water was 50 yards away down a flight of stairs, and the nearest closet 90 yards away across a muddy green. The soil is clay; a little gravel had been put down here and there, but practically the blocks stood like islands in a sea of mud. At night the only lighting of the streets was by two or three stray gas brackets fitted with the same small burners that are used for indoor lighting. The drainage however is modern and good. The following are some of the works already executed or proposed :—

(1). Abolition of all single-room quarters. Owing to the construction this necessitated a re-appropriation scheme involving 60 quarters.

(2). Provision of annexes with scullery and W.C. to every quarter. Although funds have not yet been obtained for this scheme it had to be worked out before the previous item could be proceeded with, because otherwise much of the work done in grouping the single rooms to form two-room quarters would probably have been wasted when the annexes came to be built. Now that this scheme is worked out any alterations made from time to time are arranged to fit in with it.

(3). Making up of roads and provision of footpaths between blocks. All day there is constant traffic, both wheeled and foot. Good roads and paved footpaths are considered essential and taken as a matter of course in the town outside the War Department enclosure. The density of the population inside the boundary fence of these married quarters is greater than that of the civilian population of the same social scale in the adjoining area of the town; still more therefore are the conveniences of good roads and paths required.

(4). External lighting. This is equivalent to the street lighting of the town and the same remarks apply.

(5). Fire precautions. Owing to the blocks having grown up by degrees it was found that hydrants were deficient in some places and badly situated in others. In considering how lines of hose could be brought to bear on some of the blocks it was discovered that the only route was over a wall with a coping of broken glass which would have cut the hose. Some of the buildings were 3-storied; a fire at the foot of the staircase would have cut off the escape of the occupants of the top story, this indicating the necessity of keeping long fire ladders on the spot with a shed to protect them from the weather.

(6). Other services carried out, arranged for, or under consideration are the planting of trees and hedges to relieve the dreariness of the

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rows, provision of window blinds, incandescent gas, improved kitchen ranges with automatic water supply to the boilers, larger gas mains, etc. The original gas mains were laid to supply 94 lights; extensions had been made until 247 burners were supplied off the same mains, with the result that no quarter was well lighted and some got practically no gas at all.

Enough has been said to show the class of question a Division Officer has to take up. It is a mistake to suppose that money is never available for such work. The sole secret of getting improvements lies in asking for them at the right time; viz. in the "Annual Statement of Services." We know very closely how much Part II. money will be available each year. We shall not get it all—some will be wanted for services specially chosen by the C.R.E. or the G.O.C.—but a Division Officer can count on getting a good many of his proposed services approved.

The first thing, then, to do is to form a comprehensive idea of what is wanted, and then to select the services which form the most important steps towards carrying out our schemes. It is a great help in one's choice (and a blessing to one's successor) to keep a book in which is entered every useful service, whether asked for by Units or noted by the Division Officer and his Foremen of Works. Such a book will often suggest some general scheme which will meet several independent proposals brought forward by various people at different times. Without such a record of requirements, something important is sure to be forgotten when the "Annual Statement" is compiled. Having a list of everything that has been suggested, a Division Officer can choose according to his probable funds, weighing one service against another, and making sure that no urgent one is overlooked.

Whether such a list is kept or not, there are certain stock services both Part II. and Part III., some of which are wanted in almost every Division. It is of course impossible to make a list that will include every desirable service and be applicable to every station. The following list, however, includes none that are not required somewhere. A Division Officer can add to it *ad libitum* or strike out any not required in his Division. He will then be in a position to select the schemes he decides to work on.

PART II. SERVICES.

Improvements to Barracks as a town:—

Planting trees; setting hedges to take the place of wooden fences.

Making up, kerbing, and channelling roads. Laying paved footpaths.

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Systematic lighting of roads and paths by lamp posts at regular intervals.

Means of recreation;—provision or improvement of cricket grounds, racquet courts, swimming baths, skittle alleys, stages in recreation-rooms.

Provision of clocks in barrack squares, letter boxes, street "orderly bins," sign posts.

Fire precautions;—fire engine houses, hose drying gantries, fixed fire escapes, new or larger mains, more hydrants, hydrants on upper floors of large buildings.

Improved lighting; *e.g.* incandescent in place of ordinary gas, electric light in place of oil.

Sub-soil drainage of parades, drill grounds, manèges, etc.

Improvements to cemeteries, waste spaces, grass plots.

Provision of modern conveniences :—

Telephone system in place of orderlies.

Speaking tubes in offices.

Light in offices.*

Improvements to accommodation :—

Abolition of one-room married quarters.

Provision of annexes to married quarters, or the addition of sinks with water laid on.

Provision of minor buildings; *e.g.* pioneer stores, coal stores, mineral oil stores, etc.

Provision, by building or re-appropriation, of dining rooms, squadron and company stores, R.E. stores, drying rooms.

Provision of authorised fittings :—

Hot water to all baths. Baths in officers' quarters.

Window blinds.

Beer engines in canteens and sergeants' messes (in place of brewer's fittings).

Gas meters (in place of meters hired from Gas Companies).

Cupboards in offices, picture rails in messes, shelves in sculleries, etc., etc.

Galleries for gas globes.

Lights to urine tub stands.

* No light is allowed by *Barrack Synopsis*, 1905, but see Table of authorized burners and footnote to Appendix VI. of *Regulations for Supply, Transport, and Barrack Services.*

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Replacement of old fittings by improved patterns:—

Abolition of trough and pipe latrines.
Replacement of slate baths by iron ones.
Modern fire grates in place of old-fashioned patterns.
Replacement of old pattern ranges by modern ones with constant water supply to boilers.

Alterations needed owing to changed circumstances:—

Larger mains and meters for gas and water.
Provision of relief mains, stop valves, cross connections, etc.
Additional ashbins.
Extension of fire mains, and additional hydrants near new buildings.

Miscellaneous:—

Provision of gas governors.
Provision of universal pattern heads to stopcocks and fire hydrants. (See I.G.F. Circular 725).
Provision of dry areas to damp buildings.
„ of covers to all tanks and cisterns.
„ of concrete seal under all wood floors on ground level.
Removal of disused tanks and cisterns.
Provision of safety valves to all closed hot water boilers.
„ of wire guards to exposed windows.

Some of the above items deserve a few remarks.

Hedges have two or three advantages over wooden fences. They are inexpensive, lasting, and comparatively impassable. The cost of maintenance is generally less than that of a wooden fence, and in many cases does not fall upon the War Department, because if it is in connection with a mess or quarter it is the business of the occupants to keep it in good order. In appearance the advantage is generally on the same side. The large use of hedges by railway companies is strong evidence in their favour.

A regimental officer recently remarked that 10% of the minor offences in his regiment arose from men being late for parade. The suggestion that a clock visible from the barrack rooms would reduce the prevalence of such offences and that he should ask for one in his Statement of Services was a new idea to him. At one station letters were collected from the officers' and sergeants' messes by an orderly, but the men had to walk three-quarters of a mile to post theirs. In this case the Post Office agreed to fix three letter boxes in the barracks.

As regards fire precautions, it should be remembered that the R.E. are responsible for the supply of water at convenient places. It is

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wise to make sure before any fire occurs that the hydrants are sufficiently numerous and conveniently situated, the mains ample in size, and that there is no unsuspected obstruction to the flow of water in them; and to put in your Statement of Services items for any alterations found to be required. However satisfactory the fire system may appear in the Barrack Atlas Plans, it is essential to occasionally watch the troops at practice before you can be certain that you have not overlooked some point that will cause your system to break down at the critical moment.

A parade ground that is hard and dry all the year round is very expensive. The cost of the necessary hard bottom is so great that it is often omitted, with the result that in winter some parades are often unusable. The only cure is to supply the hard bottom; the cost may have to be spread over two or three years.

The number of "employed men" is a constant source of complaint among regimental officers. No civil firm employing a thousand hands would take men away from their proper work to carry messages and run errands. Much army business is transacted by correspondence which could be done better and quicker by word of mouth. It is surprising that telephone systems connecting the administrative offices and the offices of units are not asked for oftener.

It is hardly necessary to point out the grave objections to single-room married quarters. At almost every station it is desirable to get out a complete and classified list of all the married quarters, showing against each quarter what is wanted to bring it up to modern standards; but as a rule the most urgent requirement is the abolition by re-appropriation, building, or otherwise, of such single-room quarters as still exist.

In some cases the storage room for the Division stores is inadequate or is such that safe custody or due supervision is impossible. The insertion in the Statement of an item for the provision of proper storage accommodation then becomes of importance.

It is a standing complaint in barracks that the allowance of coal is insufficient. You can help the troops by a systematic weeding out of antique and wasteful patterns of grates. Since this was written the point has been drawn attention to in D.F.W. Circular No. 897.

PART III. SERVICES.

All buildings and fittings have a certain life. If your barracks are new or have been well kept it may be possible to pay for renewals out of your incidental item. Otherwise you are likely to require items for some of the following. In many cases you can average your requirements and have the same standing items year after year; *e.g.* assuming that a married soldier's range will last 15 years, if you

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have 150 married quarters you will have to renew 10 ranges every year.

Renewing barrack room floors.
" doors and frames.
" sashes and frames.
" slate roofs and slate boarding.
" wooden fences.
" soldier's cooking apparatus.
" married soldier's ranges.
" large ranges in messes and married officers' quarters.
" fire grates.
" hot water boilers.
" wooden floors elsewhere than in barrack rooms.
" stable paving.
" gas and water mains.
" large areas of tar or other paving.
" particular fittings, such as accoutrement shelves, school desks, stable mangers, etc.
Pointing walls.
Rebuilding or topping chimneys.

Every brick or masonry building requires pointing from time to time. Units rarely requisition for such work. To do it is expensive, and brings no particular credit to a Division Officer, so it is often neglected. Places out of sight—such as the outer side of boundary walls where they abut on private grounds—sometimes escape inspection for many years. Then some day it is discovered that several thousand pounds worth of pointing is required. The systematic way to deal with such cases is to have a minor maintenance item every year, "Point brickwork," so many hundred pounds. Rebuilding or topping chimneys is a similar class of work.

In old barracks it is desirable to plan out minor maintenance work some time ahead and not live hand to mouth. Three good principles to go on are :—(1). Concentrate your funds on one barrack or one block and finish it off; do not fritter money away on patching in many places. (2). Deal with inhabited buildings first, then storehouses and stables; leave outhouses, garden walls, boundary walls, and so on till last. (3). Start at the top and work downwards. Make the chimneys sound first because a certain number of slates are sure to be broken in the process of repairing chimneys; then put the roof in order; next replace any decayed woodwork in the sash and door frames; and then do the pointing. To complete a building may of course take two or three years.

Besides regular quarterly inspections and periodical services like painting, there are in every Division various things which have to be seen to from time to time if the Division is to be well looked after.

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Some are specifically laid down, but, from being scattered about in unexpected places in Regulations, they are often overlooked, until a report is called for as to why para. so-and-so has not been complied with. The following list may be useful; it does not profess to be exhaustive; duties as to the performance of which a periodical return is required are not included—if the office list of returns is kept up to date no other reminder is required.

Clearing eaves gutters (*R.E.S.** 694).
Trimming hedges, lopping trees, clipping creepers.

Unless hedges are *properly* trimmed and the roots dug over they soon become thin at the bottom and cease to be an obstacle. The work must be done by an agricultural labourer; a town-bred man often does irreparable damage. A few years' neglect or ill-treatment of a hedge may necessitate a large expenditure on railings to replace it.

Overhaul of boilers for supply of hot water (removal of scale, test of safety valves, etc.).
Cleaning out water part of Warren's cooking apparatus (the makers recommend once in 6 months).
Testing all drainage bit by bit.
Flushing of certain drains every 6 months (*R.E.S.* App. VI.).
Testing of ventilating pipes for leakage (by smoke test).
Testing of ventilating pipes for blockage (by wooden ball lowered by a string).
Testing of automatic flushing apparatus. This is a weekly duty of the troops (*R.E.S.* App. VI.); but the apparatus is often so constructed that the troops cannot comply, and in any case constant supervision is needed.
Washing of window blinds (*R.E.S.* 737).
Cleaning of tanks (*R.E.S.* 895).
Painting of manhole covers (*R.E.S.* 855).
Testing of gas mains and services (*R.E.S.* 844).

It saves trouble in the long run always to send a representative with the Army Service Corps when they make the quarterly test laid down in *Regulations for Supply, Transport, and Barrack Services.*

Testing of water mains and fittings. (Similar to test of gas mains; see *K.R.* 400 and *R.E.S.* 888).
Verification of inventories and lettering of buildings, including fuel units.
Inspection of skittle alleys (*R.E.S.* 732).
Sweeping of ventilating flues and shafts.

In the path of a Division Officer trying to effect all the repairs and provide all the conveniences asked for by other branches of the

* *Regulations for Engineer Services.*

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service are many pitfalls. They are of course matters which every Division Officer should know; but unless they are all constantly borne in mind, at some time or another one is sure to fall into a trap and trouble and correspondence result. Some of the commoner ones are as follows:—

(1). Distinction between "Barrack Annual Estimate," "Fortification Annual Estimate," and "Army Ordnance Buildings Estimate." Money in one estimate is not available to help out another, and no local transfer is possible (*R.E.S.* 783).

(2). Distinction between Part II. and Part III. Funds (*R.E.S.* 407). Part III. money (*e.g.* incidental items) is available for repairs and maintenance *only;* it is *not* available for anything new (*R.E.S.* 788). Similarly Part II. money is not available for repairs or renewals; no local transfer is possible (*R.E.S.* 783).

(3). New Services. G.O.C.'s authority (at home that of the Major-General i c Administration) is needed for *any* new service; he alone can authorize a Part II. item (*R.E.S.* 783).

(4). Proposals for new accommodation or fittings. These should be tested by the *Barrack Synopsis,* and should not be entertained unless they are in accordance with it or there are exceptional reasons for departing from it; *e.g.* there should be exceptional circumstances before you recommend the addition at Government expense of a gas hot-plate in a mess already fully equipped according to *Synopsis.*

(5). Alterations to buildings and fittings should be tested by the "Construction Return." If you are asked to put racks in a company store make sure that it is a company store and not really a barrack room misappropriated as a store.

(6). Fittings should be verified by the inventory before they are repaired or altered; *e.g.* when you are asked to repair the beer engine of a sergeants' mess make sure that the engine is a War Department one and does not belong to a brewer.

(7). Supply of Fittings. Make sure that fittings asked for are an R.E. and not an Army Service Corps supply; *e.g.* foot gratings to sergeants' mess sculleries are an R.E. supply (*Synopsis*), but those in ablution rooms are an Army Service Corps supply (*R.E.S.* 723).

(8). Duties of the troops. A Division Officer is asked to do many things which, by regulation, are the duty of the troops or of some other Department; he must be constantly on the watch to see that the Vote for Works is not saddled with the cost of such services. The following are either not Engineer services at all, or only to a limited extent and under the conditions laid down in the paragraphs of *R.E.S.* quoted:—

Artificers' tools, repair of (601).
Artillery matériel, repair and painting of (738).
Beer engines, repair and maintenance of (720–721).
Billiard-room fitments, repairs to (797).

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Boats, repair of (740).
Cisterns, cleaning of (895).
Cricket grounds, maintenance of (729, but see also *K.R.* 322).
Disinfection of rooms (712).
Drainage, routine work in connection with (App. VI.).
Drawing instruments, repairs to (960).
Floor margins, staining of (696).
Fitments, supply of (722–3).
Furniture, supply of (722–3).
Gardens, upkeep of (796).
Glass in canteens, repair of (718).
Glass generally, repair of (714–9, but see also 743, 757, 765).
Greenhouses, upkeep of (714).
Jumps for mounted corps, maintenance of (734–6).
Lime for disinfecting, supply of (712–3).
Lime whiting (701 and 704–9).
Machinery, repairs to certain (688).
Parades, rolling, sweeping, weeding, etc., of (728).
Rifle ranges, upkeep of (724).
Roads, scraping, rolling, sweeping, etc. (728).
Skittle alleys, repairs to platforms and buffers of (732).
Snow, removal of (692–3).
Surveying instruments, repairs to (960).
Transport (425).
Water supply, routine work in connection with (App. VI.).

One is constantly getting requisitions to clear stable gullies, scrape roads, repair paths, etc. If once you start doing such work for the troops you will have employment for three or four permanent men, whose wages will absorb a large percentage of your incidental item without anything to show for the money spent.

(9). Limewashing. The troops are always asking the R.E. to limewash buildings for them. Without the sanction of the G.O.C. civil labour can only be employed in a few special cases (703–4, 712); all ordinary limewashing has to be done by the troops themselves (705).

(10). Distempering. Certain buildings of better class are allowed by *Synopsis* to be distempered instead of limewashed. They may be distempered by civil labour, but only once in two years (697) except in certain cases (709, 712).

(11). Papering and painting. Requests to have officers' quarters and messes papered and painted are very common; but it may only be done at fixed periods (695), unless the G.O.C. has previously approved of its being done at other than the proper time, or after a case of infectious disease (712).

(12). Repairs of glass. Practically all broken glass has to be made good at the expense of the occupants (714—719). There are certain

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modifications in the case of lunatics (743), recruits (757), and prisoners (765), and in certain cases by a particular procedure a Division Officer can charge the repair to the public (716); but the troops, perhaps naturally, try to avoid the instructions plainly laid down. A common method is to send in a requisition with a certificate that the damage has been caused by persons unknown. The answer to this is exactly the same as the answer that the tenant of a private house would receive if he asked the landlord to repair glass under similar circumstances, viz., it is your business to discover the unknown persons and if you cannot recover the cost from them you must bear the loss yourself.

(13). Damages generally. A Division Officer is the man to say if a breakage or deficiency is a damage or not, and there is an appeal to the C.R.E. (742). But the R.E. are not the arbiters as to who should pay; that is a matter of discipline for the local commandant. For instance, if a door in an unoccupied building is left to blow about with the wind and gets broken, it is for the Division Officer to say whether the breakage is due to neglect or not, and there is an appeal through the C.R.E. to the G.O.C. But if the final decision is that the cost of repair is not chargeable to the public, then, in the event of any dispute as to responsibility, it is for the local commandant, not the R.E., to say who should pay. Nor are the R.E. called upon to distinguish between individuals. When damages are found in a quarter which has been continuously on charge of some unit, the unit is responsible although the individual who caused the damage may have left the station. The collection from the particular individual at fault of the sum due is a regimental matter (*K.R.* 320).

(14). Use of buildings. A Division Officer has nothing to do with the allotment of buildings. When a new saddle room is added to a stable, it is on completion handed over to the Army Service Corps. It is for them to decide between rival claimants to the use of it. Nor is it an R.E. question what use the occupants actually put it to (provided they make no alterations, see *K.R.* 330); that also is a matter for the Army Service Corps (*Regs. for S.T. and B. Services*); but it may be desirable to bring it to the notice of the C.R.E. with a view to reappropriation under para. 359, *K.R.*

(15). Requisitions must be examined for items which are not due to fair wear and tear (*R.E.S.* 749 and 795). Items such as "accoutrement shelf deficient," "clear stopped drain," "lavatory basin cracked," are *prima facie* damages until a satisfactory explanation is forthcoming. Items which are the duty of the troops (see above) must also be excepted.

(16). Articles included in the *Vocabulary of Stores* must not be obtained from the Triennial Contractor, even when there is an item in the schedule (*R.E.S.* 936). This applies to articles like rope, nails, paint, etc., but not to special building stores (930).

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(17). Purchase of stores locally. Vocabulary stores must be purchased through the Army Ordnance Department (936). The purchase of other stores is governed by D.F.W. Circular 900; but this is interpreted in various ways in different Districts, and the local routine must be adhered to if delay and correspondence are to be avoided.

Specifications for stores to be purchased locally almost invariably require a clause somewhat as follows:—"To be delivered free of all charges for packing, carriage, and delivery, addressed in oil to the Division Officer at the R.E. Stores ____within_____weeks (or days) of receipt of order."

GENERAL REMARKS.

A Contractor whose profit depends on the amount of work he can get out of his men can almost always do work at a cheaper rate than it can be done by labour directly enployed by the War Department. At stations where there is a triennial contract it is desirable therefore to reduce to the lowest possible extent the number of men directly employed. In every Division there are odd jobs to be done, not covered by any requisition; but it is distinctly more economical to put as many of such jobs as possible on requisition, and, where day-work is unavoidable, to obtain men temporarily from the Contractor than to keep several permanent men for whom work has to be found at all times.

An analysis of the Barrack Incidental Item will often show the direction in which economies are possible. The following Table, giving particulars of two years expenditure in a Division, shows that nearly 40% of the work of the directly employed men is taken up in odd jobs, and suggests enquiry as to what those jobs are and whether they are worth the cost.

EXPENDITURE ON BARRACK INCIDENTAL ITEM.

	Percentages.		
	1st year.	2nd year.	Average.
Wages of men directly employed, not accounted for on any requisition	5·3	5·4	5·35
Ditto, accounted for	7·9	8·6	8·25
Stores obtained for use of men directly employed.	2·6	1·3	1·95
Work on requisition done by T.C.	78·2	81·7	79·95
Stores obtained under D.F.W. Contracts	1·8	3·0	2·40
One lot of Stores obtained under special circumstances	4·2		2·10
	100·00	100·00	100·00

Proportion of wages of directly employed men unaccounted for, 5·35 out of a total of 13·60, or 39·63 per cent.

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If the War Department is to have the benefit of a large percentage off schedule rates the Triennial Contractor's bills must be regularly passed for payment without delay. The total profit a Triennial Contractor makes is dependent on the amount of money paid to him by a Division, irrespective of how often he turns over his money. But the number of times he can turn it over in the year greatly affects the liquid capital he requires and the percentage of profit he makes on that capital. Suppose he is paid £5,000 a year, and that out of this he is making the usual builder's profit of 10%; then he will pay away £4,545 in labour and materials, and make a profit of £455. If he has to wait four months for his money, he will need ⅓ of £4,545 or £1,515 ready money to carry on the work until payment begins; if he is paid every 5½ weeks, he will only require $\frac{1}{10}$ of £4,545 or £455. Disregarding capital sunk in plant, at the end of a year in the one case he will have made £455 on £1,515, *i.e.* 30%, and in the other £455 on £455, *i.e.* 100%. The difference between the sums required is £1,060. He may employ this elsewhere; and if he turns it over 3 times in the year, he will make £288 more. Quicker payment will in that case enable him to earn £288 more on the same capital. If, instead of receiving £5,000, he only receives (£5,000 − £288 =) £4,712, but more promptly, he will be in exactly the same position as before. If net rates produce £5,000, a deduction of 5¾% will produce £4,712; and next time the contract is open for competition, he can tender at a deduction of that amount. In a Division where £5,000 a year is paid to the Triennial Contractor a deduction of 5% off schedule rates means a saving to the War Department of £250 a year, or £250 a year more to be spent in the Division.

In siting new buildings, the future often deserves more consideration than it gets. When there is vacant space available—and at the time the exact position of some new building does not much matter—the future state of affairs, when all the vacant area is built over, is apt to be overlooked. Before any permanent building however small is put up, the roads in the vicinity that will be required 20 years hence should be decided on. This will give a "building line" to which all new buildings should conform. Such a line makes all the difference between a row of buildings forming a street and the same buildings scattered about irregularly, close together where the traffic needs wide roads and widely separated where convenience requires them to be side by side. Having planned out the development of a vacant space, reserve the best sites for important buildings; do not waste corner plots on some small outhouse which can go equally well in some less prominent position. Many instances can be pointed out where want of foresight in such matters in the past is the cause of inconvenience at the present time.

War Department buildings are exempt from most of the provisions of the Public Health Acts and from the building bye-laws made under those Acts. They should, however, be at least up to the standard

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required in civil buildings. A Division Officer is often required to give an opinion as to the habitability of some building, especially in old barracks, such as huts, basement rooms, or old and out-of-the-way married quarters. Of course in time of emergency bye-laws cannot be regarded, but they give a standard for buildings meant for permanent occupation in peace time. A room in the basement of a mess, which does not come up to the standard required by the Public Health Act of 1875 in a "cellar dwelling," can hardly be considered fit for a messman's quarter or for a mess waiter's bedroom. On the other hand do not condemn a building offhand merely because it is dingy; that may be your own fault because you have not kept it in repair and painted it when due, or it may be the fault of the troops in not keeping it clean.

From time to time epidemics of some disease, such as typhoid or diphtheria, occur in barracks. Although such matters are primarily questions for the Medical Officers yet there is a good deal a Division Officer can do to help them. A "spot map" is a plan on which is marked by a dot the position occupied by the bed of each case at the time of seizure, or at least at the time of admission to hospital. A spot map has its limitations; but it may, and often does, point plainly to something in the buildings occupied, if not the actual cause of the epidemic at least a predisposing one, which might otherwise have escaped notice.

One of the chief difficulties in Division work is to find out what the occupants of War Department buildings really want. They seldom suggest any comprehensive scheme of improvements; in minor matters the improvements asked for are sporadic and often conflicting. For example, you are asked to put a boiler in a cookhouse, when what is really required is hot water laid on to the baths in a neighbouring bath house; and even this may be only a part of what is really required; it may be that there is no hot water in any of the bath houses, and, instead of a £5 estimate for a boiler in a cookhouse, in the end you get out a £150 scheme for hot water in half-a-dozen different places.

Schemes for the benefit of more than one unit must generally originate in the R.E. office. There are innumerable alterations and improvements, some small in themselves and of little cost, others large and expensive, by which the labour of the troops can be lessened and their comfort increased. Useful suggestions can be obtained from the Quartermasters, the Medical Officers, the Chaplain, and others. But it is the Division Officer who has to work out their ideas and put them in a practicable form. The work is by no means a dull round of petty repairs and routine maintenance. An Officer who has never done any Division work is hardly in a position to express any opinion about it. One who has been a Division Officer and has not found any points of interest in it must either have shut his eyes or else must be a man of very narrow interests.

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TRANSCRIPT.

SOME FORTIFICATION DEDUCTIONS FROM THE STRUGGLE FOR PORT ARTHUR.*

By A. B. VON SWARTZ, *dated Port Arthur, October—November*, 1904.

THE struggle for the possession of the Kwangtung peninsular, which began with the series of battles of May, June, and July, 1904, and culminated in the 5 months' siege of Port Arthur, frequently verified the force of the old maxim "more earth dug—less blood shed," and bore testimony to the fact that in modern warfare engineering tools are of no less importance than magazine rifles and quick-firing guns. As the development of artillery progresses and as the rifle becomes more deadly at long ranges, so much the more important becomes the *rôle* of fortification in opposing them. The greater the number of bullets in shrapnel and of splinters in howitzer shells, and the steeper the fall of their trajectories, the deeper must be the entrenchments and the more perfect the cover afforded by them.

In artillery the present campaign has produced an entire change. Formerly guns were placed on hills and fired at visible targets; now they are hidden behind hills and the targets are not visible from the firing points. In fortification the substance remains as of old—ditch and bank—only in dimensions and some fortification developments have changes occurred. In relation to these changes the struggle for Port Arthur has produced many interesting features, and in the following notes, which were jotted down as time permitted during the fighting, will be found everything which attracted my notice as being of especial interest to our work.

ORGANISATION OF PORT ARTHUR FORTRESS GENERALLY AND OF THE FORTS PARTICULARLY.

The fortress of Port Arthur consists of a girdle of forts (six in number, of which one was not completed) and of a central enclosure covering the old town.

The distance of the forts from the centre of the town (where lies the port) is from 2 to 2½ miles; and the distance of the line of the central enclosure (which encircles the town) from its centre is from 1 to 1½ miles.

* Translated by permission from articles in the September and October, 1905, numbers of the *Kenzhenernee Zhoornal*. The original was accompanied by an excellent map of the northern defences of Port Arthur, on a scale of 700 ft. = 1 inch.

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The enemy posted his guns at a distance of from $1\frac{2}{3}$ to $3\frac{1}{3}$ miles beyond our forts, and from the very beginning of the siege succeeded in bombarding the town with 6-inch guns, and in September with 11-inch guns, while as he drew nearer he shelled it with field and 57-millimètre guns. In October, having advanced as far as the forts, he was even able to fire into the town with rifles. The most distant battery from which he threw shell, which daily took effect upon the town, was nearly 6 miles away, and the distance of this battery from our nearest fort (Erlungshan) was $3\frac{1}{4}$ miles. The nearest of the batteries of the enemy's first artillery position was $1\frac{2}{3}$ miles from the line of forts. Consequently, to have preserved from bombardment not only the centre but also that portion of the central bulk of the town which is nearest to the central enclosure, it would have been indispensable to have moved forward the forts to a distance of not less than 6 miles from the centre.

The shortest interval between the forts laterally was $1\frac{2}{3}$ miles (between forts Erlungshan* and North Keekwan) and the greatest $2\frac{1}{3}$ miles. However, owing to the broken nature of the country even the gap of $1\frac{2}{3}$ miles seemed too wide.

Conditions Governing Distance Apart of Forts.

Consequently, in deciding how near to one another forts should be placed, the following indispensable conditions must be taken into consideration :-

1. If the country is level, the forts must be near enough to bring a powerful cross fire of rifles as well as of guns over the whole of the intervening ground. In this case the size of the gaps depends partly on the existence of sites suitable for the forts, but it must not be greater than double the range of effective rifle fire (*i.e.*, 3,000 yards). The ground must be thoroughly cleared so that there may not exist between the forts a single inch of ground which is not swept by their fire.

If a gap has additional importance owing to the existence of any important objects in rear of it, it would be extremely useful to connect the gorges of the forts by a rampart and ditch. It was only due to the existence of a rampart of this kind (the Chinese wall) between forts Erlungshan and North Keekwan that we were able to drive back the enemy's assaults on this interval during the month of August.

2. When the country is deeply indented and consists of a series of hills and deep ravines, the forts should be brought nearer together. In this case they must be sited so as to see one another; and if it is not possible for them to command with their fire all the intervening ground, there should be placed between them one, two, or even more, permanent works, of the same or some different type, with this one important object—not to leave one single piece of dead ground between them.

Unfortunately this was not the case at Port Arthur, especially in the gap between the two forts above-mentioned, and the Japanese were not slow to appreciate the defect and to take full advantage of it. These forts

* Erlungshan was the north salient and North Keekwan east by south of it.—F.E.G.S.

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were placed on heights standing somewhat forward from the main line of the Dragon Range. Between them were four hills, all exceeding in elevation the site of fort Erlungshan and two of them almost equal to that of North Keekwan; the hills were separated from one another and from the forts by five deep ravines. The forts could not see one another and the ravines were not commanded by their fire. When the defences of Port Arthur were taken in hand in the spring of 1904, works were designed for these hills, redoubts for the two centre ones and light field works (called open caponiers) for the two outer ones. But these works were only partially made; and, as they were only of a temporary nature and had no exterior ditches, they did not offer very serious obstacles and were enveloped during the first assault.

This and other experiences have shown that it is useless to put works of a temporary nature in the intervals between forts, for the power of modern siege artillery fire is so terrific that nothing but concrete of considerable thickness can serve as safe cover.

The defences in the gaps between forts must be taken in hand in good time and they must possess all the important features of permanent fortifications, differing only from the latter in point of size. (The 'subsidiary works' at Port Arthur are examples of this).

It is important also to arrange for mutual aid between works by means of rear caponiers. Thus the caponier in rear of fort Erlungshan gave great assistance to 'subsidiary work' No. 3,* and the "open caponier" No. 3, in the gap between forts Erlungshan and North Keekwan, gave much help to the former fort.

DESIDERATA IN DESIGN OF FORTS.

The following are some of the most indispensable requirements of all forts and subsidiary works:—

1. A fort must have a good field of fire for rifles up to 2,000 paces from all its faces. (We did not have this).

2. Neither in front nor on the flanks of forts must there be any dead ground. Sometimes, owing to the nature of the ground, this can only be attained by a suitable arrangement of the neighbouring subsidiary works.

3. Heavy artillery placed in forts and similar works draws upon them such a heavy fire from the enemy's guns that it leads to premature damage to the forts and to a consequent saving of ammunition on the part of the enemy. Therefore heavy artillery must not be put inside forts (as was done in the case of some of the forts at Port Arthur).

4. Each fort must be equipped with a large number of light guns for opposing storming parties. These guns should be quick-firing. (We had only old field guns, and in fort Erlungshan even less useful weapons and only three of them).

5. At every angle and in the middle of the sides there must be platforms, each for two of these guns, and in the intervals between them places for machine guns. (In fort Erlungshan there were only two machine guns;

* Sungshushan, about ½ mile west by south of Erlungshan.—F.E.G.S.

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these proved insufficient, and there were added afterwards two automatic quick-firers).

6. Concrete shelters must be provided close by for these guns.

7. The guns should be mounted either in armoured turrets of the rising and disappearing type, or should be completely under cover, firing through embrasures in the shelters.

8. As regards infantry fire this siege has shown the immense importance of providing some new arrangement for rifle fire. I can say with full assurance that *the designs of the days of infantry parapets without head cover for the riflemen must now be put away among the curiosities of ancient history.*

Furthermore, the experiences of this war bear witness that it is useless to build up light parapets, blinded and traversed with sandbags as in field defences, for these are rapidly and easily destroyed by the shells of heavy guns. This is a question which calls for the serious consideration of Engineers. I myself think that it could be successfully solved by constructing along the parapets concrete galleries with loopholes for the riflemen.*

9. It is extremely important during fighting or bombardment to have uninterrupted communication between the parapets and the casemated barracks in the gorge. This can only be arranged by means of underground galleries, because the force of modern artillery fire is so great that it makes all partially covered communications useless. (In fort Erlungshan men were killed daily while crossing from the banquettes on the faces to the barracks in the gorge). Covered banquettes constructed as suggested in the previous para. might usefully be made to serve also for communications.

10. In addition to an open sally-port there should also be a tunnelled entrance, leading from some place not exposed to the fire of the fort, so that fire can be brought at all times to bear on all the rear approaches. (In fort Erlungshan there was only one open sally-port).

11. At all times during a siege a fort must be in uninterrupted communication with the fortress staff. The arrangements made by us, which consisted of aërial telephones and cables laid on the ground, did not answer their purpose well, as they were often cut by shells during the crises of the fighting. For this reason special arrangements should be made in good time for burying the cables in pipes of small diameter specially laid for that purpose.

12. In order to maintain the necessary observation of the enemy from the forts during both fighting and bombardments, it is evident that sentries cannot be posted without suitable protection, and there should be provided for their use in each fort two armoured rotating turrets or concrete emplacements. Telephones and electric signals should communicate from these conning towers with the casemated barracks by lines not liable to interruption.

13. Search lights should not be fixed within forts; they should be outside and to the flanks. But the concrete casemates for the boilers and dynamos must be inside the forts.

* When I visited in June, 1905, the works of Colonel A. P. SHOSHENA, I saw that he had arrived at the same conclusion as myself and had built a portion of a similar gallery.

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14. The casemated barracks for the garrison should as heretofore be in the gorge. But there must also be casemates for the guards told off daily for manning the parapets, and these should be in direct communication with the galleries leading from the parapets to the casemated barracks.

15. The barracks for the garrison must have sufficient space, light, and air. We have never turned our attention sufficiently to ventilation and prevention of damp in casemated barracks, and consequently in the forts many of our men get ill.*

The following are indispensable:—separate quarters for officers, a cookhouse, two storerooms, a small arm ammunition magazine, and a latrine. There should be two completely covered entrances on the flanks; also another about the centre, giving into the inner court in the ditch, open to the air but beneath the level of the bottom of the ditch. Sufficient and good lighting must also be provided.

16. In every fort there should be a well or some other reliable water supply. (With us in the forts the water is stored in casks, but this supply is soon wasted and it is not always possible to replenish it).

17. As a precaution against fire (such as occurred on the 21st August in fort Erlungshan) no wooden structure should be allowed within a fort.

18. There can remain no doubt as to the value of concrete for buildings in time of war; but a thickness even of 4 feet for concrete walls without a covering of earth proved insufficient.

19. The great value of a covering of earth over concrete structures was proved in fort Erlungshan. A covering of 4 to 5 feet of earth effectually preserved a casemate with a concrete vaulted roof from damage. On one occasion 11-inch shells fell on it, in one place, one after another, and after them 6-inch shells, but the arch was not broken.

20. The deep ditches with vertical sides of fort Erlungshan proved an insurmountable obstacle to the enemy.

21. The ease with which the Japanese obtained possession of the caponiers beyond the counterscarps in forts Erlungshan and North Keekwan shows clearly the danger of such structures. The question of the best means of flanking ditches deserves careful consideration. Experience shows that the arrangements for the defence of ditches must be guided by the following considerations:—

(*a*). They must be well under cover.

(*b*). Both flanking and frontal defences must be provided, so that if one is lost the other may still remain available.

(*c*). Flanking defence is preferable; it is impossible to trust to frontal only.

(*d*). Machine guns and automatic quick-firers must be available for the defence of the ditch.

* In fort Erlungshan the casemated barrack provided for one company is like a tunnel, 9 feet wide. There are at present living in it two companies with their officers, besides gunners and sappers. Here also the cooking is done, and here are stores of water, food, and warlike materials. The ditch of the gorge serves as a latrine.

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22. At the time of constructing the fort a system of counter-mines should be arranged; and these should be extended 100 to 140 feet from the counterscarp.

23. In all concrete buildings care should be taken to leave no sharp angles; all angles should be rounded off, or they will be knocked away by shells even of small calibre.

24. The question of masking the fort should not be overlooked at the time of its construction.

25. Works covering the entrances are useful, but they should be defiladed from the dropping fire of large shells. (Fort North Keekwan suffered from the neglect of this precaution).

26. Doors and window shutters should be of one-inch steel, to be proof against the splinters of small and medium-sized shells.

27. The garrison of a fort should not be less than 400 men, to enable it to be independent of outside assistance and to supply the necessary working parties for repairing the defences.

Batteries in the Intervals between Forts.

The greater number of the batteries between the forts were placed at Port Arthur on the tops of hills for firing at visible targets; most of the long-range guns were in these batteries, while the rest were mounted within the forts and subsidiary works. All our guns were well sited for long-range fire and badly sited for short. Some batteries posted on hills were plainly visible from a distance, as for example the Great Eagle's Nest Battery* (two 6-inch Canet), the subsidiary work at Sungshushan (same armament), and the Zaleeternaya battery† (two 15-c.m.). The guns in all these works were disabled in the course of the first two months.

Among the well-sited batteries may be mentioned the howitzer battery on the Obelisk Hill, the Great Howitzer Battery,‡ Zaredutnaya Battery§ (four 6-inch of 4,330 lbs.), the Tumulus Battery,‖ and the batteries of the second line of defence.

The following are some features necessary in batteries:—

1. Guns of large calibre, intended to engage the siege artillery of the enemy, must not be placed in forts but in the intervals between and slightly (200 to 350 yards) in rear of them. (In fort Erlungshan there was a battery of four 6-inch guns of 4,330 lbs. and in forts Nos. 1 and 4 the same number of 6-inch guns of 6,859 lbs.).

2. Small separate batteries are more difficult to hit than large ones, and therefore it is best to build a large number of batteries, each for a small number of guns. Thus it is better to have two guns than four in a battery.¶

3. A battery should not be placed on the crest of a hill unless it is only for flanking purposes.

* On the Dragon Range west of North Keekwan Fort.—F.E.G.S.
† South of North Keekwan.—F.E.G.S.
‡ On the Dragon Range midway between Erlungshan and North Keekwan.
§ Just east of the Great Howitzer.—F.E.G.S.
‖ South of Sungshushan work.—F.E.G.S.
¶ This refers only to temporary batteries; the permanent ones should be constructed for four guns each, and they should have near them small concrete casemated barracks for the garrison.

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4. In the interval between two adjacent forts there must be four permanent concrete batteries, armed in good time, secure against assault, and provided with accommodation for the necessary infantry garrisons.

It would be useful to have in each battery some machine guns which can be brought into action at the moment of an assault. Battery B° was assaulted six times and each assault resulted in hand-to-hand fighting.

5. In the intervals between the permanent batteries there should be prepared two or three batteries of a temporary type, some to be armed with heavy guns at the time of mobilisation and others to be held in reserve. Any other batteries which may be necessary can be constructed during mobilisation.

6. This siege fully bears out the vast importance of howitzers in defence. I personally think that the proportion of howitzers in a fortress should not be less than 50 per cent. In destructiveness and in moral effect they far exceed other siege guns. The Japanese prisoners spoke of them with as much horror as we ourselves experienced when the Japanese howitzers began to fire.

7. Howitzers should be placed in pairs. (The Japanese even posted theirs singly).

8. Batteries for howitzers must be sited behind hills to fire at invisible targets. To disable a howitzer is very difficult and this fact largely increases the value of this weapon.

9. The Japanese did not fire salvos with howitzers, but our side sometimes did so with two or even four at moving targets.

10. In concrete batteries the guns should be mounted on disappearing carriages if the battery is not behind cover.

11. Traverses between guns should have a covering of earth, or otherwise should consist of very thick arches.

12. The corners of traverses must be rounded off. In fort Erlungshan the destruction of the traverses began by their corners being knocked away and once begun was steadily increased.

13. During the whole siege the number of fortress guns with us was hardly less than with the Japanese, and yet no sooner had the artillery dual commenced than the preponderance of the Japanese fire became evident. This is explained by the following peculiarities:—

(*a*). All the Japanese guns were quick-firing and ours were the reverse.

(*b*). The Japanese had the power of removing their guns and concentrating them wherever they were required. But with us, when once our guns were in position, we could not move them; no new batteries were armed; and only to replace disabled guns were any moved from the western face to the eastern.

It appears therefore that the armament of a modern fortress must consist of:—

(i.). Long range and quick-firing guns of medium calibres (120 m.m. or 6-inch Canet).

* South-east of North Keekwan and just east of Zaleeternaya Battery.—F.E.G.S.

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(ii.). A certain number of long-range guns of large calibre, such as 10-inch, posted behind cover.
(iii.). 50 per cent. howitzers (from 6-inch to 11-inch).
(iv.). Besides these it is necessary to have a certain percentage of guns of medium calibres in store and with the reserve.
(v.). It is also important to have in a fortress two or three divisions of quick-firing field guns and also some 37 m.m. and 47 m.m guns for use at the shortest ranges against storming parties. Our field artillery was of great assistance in repulsing assaults.

(14). It is extremely important to take measures for masking batteries. To effect this, care should be taken to keep them as near as possible to the colour and general level of the surrounding country. Earth parapets should be avoided, the parapet being the natural surface of the ground and the battery itself excavated.

(15). In addition to the real batteries it was found very useful to make some false ones in which dummy guns were stood and flashes occasionally fired in them. The enemy expended much ammunition on such batteries before he recognised their object. But it does not follow that it is sound to place dummies in real batteries.

16. As soon as the direction of the attack has been clearly shown, the following should be done in the intervals between the forts of the threatened front:—

(i.). Construct some batteries for quick-firing guns to oppose assaults.
(ii.). Arm the reserve batteries (see para. 5 above).
(iii.). Reinforce the artillery in the threatened front with guns from the reserve.
(iv.). Construct some batteries for special action against the enemy's siege works.

In Port Arthur the batteries for opposing assaults were constructed so that the guns could usually be kept under shelters and brought up into the firing positions at the moment of the assault by means of ramps. Near the batteries were also casemates for the men serving the guns. Between each two firing platforms was a traverse with two recesses in it for ammunition. On the outer sides of the firing platforms were small trenches for the gunners, with light cover from shrapnel.

When the fortress is armed there should be provided a large number of 18-pr. and 36-pr. howitzers for use against the enemy's siege works. Our field grenades were not suitable for this purpose, and the 6-inch howitzers and guns could not throw shell so short a distance. Not having these light howitzers we could not actively oppose the enemy's saps.

Communications within the Fortress.

As the enemy drew nearer to the forts our communications with the centre of the fortress and between ourselves became more difficult. It was soon evident that the field roads constructed within the fortress, however well aligned for peace time, were quite unsuitable for use during

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a siege. They were consequently abandoned, and communication was established by the ravines between the hills; and in those places where it became necessary to cross a rise, a road of communication was excavated through it.

A great part of the roads were so constructed that they were visible to the enemy from a distance, and therefore it is not surprising that the Japanese on occasions fired shrapnel even at individuals travelling along them. Thus in daylight not only was it impossible to use the roads for driving on or for transporting ammunition or war materials within the position, but even communicating with us was very difficult. By night the enemy kept up fire on the roads with rifles.

This matter is extremely important. When constructing a fortress in peace time the roads should be so aligned that they shall not be visible to the enemy or raked by his fire.

In places where there are hills and ravines the road should be carried behind the hills, no attention being paid to the necessary increase in length. In exposed places the road must be carried through in tunnels, for in no case should it pass over an exposed piece of country. In the case of the roads between forts the same rules apply, with this exception that on the side towards the enemy there must be an earthern parapet sufficiently high to cover the whole road from shrapnel.

As regards fortress railways with steam traction, in Port Arthur there were none and we did not experience any special need of them. But the use of such during a siege would be attended by much difficulty. The enemy would always know the direction of the line. He would certainly learn this in peace time from spies, and during the siege he would place batteries to command parts of the line and would destroy passing trains. By night he would command it as thoroughly as by day, being warned by the noise of the approach of trains. I am convinced that a permanent railway would not prove as useful as it might be expected to be.

It would be quite another matter to arrange under cover of a parapet a tram line connecting the forts, for transporting guns to the various works. The idea was long ago proposed by French engineers, and the present siege has fully proved its usefulness. If we had had such a line at Port Arthur it would have been immensely useful in helping the rapid concentration in a given place of a sufficient number of guns for opposing assaults.

But it is also clearly evident that the artillery in a fortress should not be fixed but should be capable of being moved. That is why it is so important in peace time to construct such a large number of batteries in the intervals between the forts. Those which are standing unarmed are ready to be armed, as soon as the direction of the attack has finally declared itself, with guns either from the reserve or withdrawn from the unthreatened fronts. Besides this some of the batteries can be held in reserve, either for use against other objectives or especially, when the enemy is bombarding one particular battery, its guns can be rapidly removed into one of the reserve batteries, which the enemy will have to discover and bombard in its turn, thereby expending much time and ammunition. The Japanese often did this. Silence on the part of any

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of their batteries brought perplexity into the minds of our gunners; and then suddenly new batteries would open fire and the old ones appear unarmed. The Japanese arranged their batteries for over-bank fire, but a few had embrasures. Every possible contrivance was resorted to for masking these: for example, they gave the battery the same elevation as the trench; they made false embrasures and veiled the real ones with cloths; they also stuck plants of kowliang into the parapet, but this was not very successful as the colour of dry kowliang differed from that of the growing plants.

As I frequently witnessed the artillery duels I always noticed that the enemy concentrated the fire of two or three of his batteries on one of ours. He destroyed the works with various kinds of shells and the gunners who were endeavouring to reply with shrapnel. The rapid fire of the Japanese guns and their superiority in numbers soon crushed our batteries. They ceased fire and the men, driven into the blindages, awaited an opportunity of replying. On such occasions our fire was feeble and that of the enemy uninterrupted.

When the fortification or battery at which they were firing was sufficiently destroyed, the enemy brought up his troops for assault under cover of shrapnel. *I therefore maintain that the number of batteries in the intervals between forts should be increased and the number of guns in each diminished. It would then be more difficult for the enemy to concentrate the fire of two or three batteries on each one of ours. He would be obliged to disperse his fire among all our batteries; his fire would thus be weaker and consequently the combat would be less unequal.*

Search Lights.

In the defence of Port Arthur two novelties were tried for the first time:—

(1). The lighting up of the ground in front of localities by search lights, and

(2). An electric fence as an obstacle against assault.

Neither of these novelties had particular success. The electric fence was surmounted by the Japanese by throwing on it special metallic hooks, the ends of which led away the electric fluid into the ground; and by cutting down the posts with pyroxyline.

As to the search lights during the first weeks of the siege, the lighting up of the ground by them did not produce any advantage; it revealed neither the transporting of the enemy's guns, nor his new works, nor the movements of his troops. It is possible that in places perfectly level search lights might be useful; but in intersected ground, with masses of various ravines and gullies, they were no good. Later on, when the enemy had captured East and West Panlung redoubts,* we tried to prevent him from putting them in a state of defence by lighting them up at night. This was found to be much more effective than even artillery fire.

* On the two centre of the four hills between Erlungshan and North Keekwan.—F.E.G.S.

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The following points generally hold good :—

(1). Search lights are useful for lighting up the very near approaches to forts and other works, up to a distance of 600 to 800 paces.

(2). They must be so placed that they can light up the ground in the intervals between the forts as well as the approaches to the forts themselves.

(3). The number required must be determined as follows :—Three to each fort (one in front for the threatened face and two for the flanks) and two or three for the intervals between forts (not necessarily in the forts but near them).

(4). Lights which are fixtures must be placed in armoured or concrete emplacements ; but it is far better that the lights should be movable.

The arrangements for the search lights in fort Erlungshan were as follows :—Each light was kept in a trench at the foot of the glacis ; it was fixed to a truck and by day was placed under a special blindage ; when required for use it was run up a light rail about 35 feet to the front, into an emplacement where it was protected by a parapet up to the level of the mirror. With this arrangement the enemy's fire of shell and shrapnel, even in salvos, proved ineffectual ; but most of the lights were destroyed by rifle bullets when the enemy came to closer quarters. At the period of close attack search lights would prove a most important factor in the final struggle.

ASSAULTS AND MEASURES FOR OPPOSING THEM.

The enemy generally prepared for his assaults by bombardments. According to the requirements of the object in hand the bombardment was sometimes prolonged, sometimes of short duration.

The general assault on Port Arthur on the 21st August was preceded by an almost uninterrupted bombardment ; it commenced on the 18th August at 4 o'clock and continued till 7 o'clock at night ; on the 19th the bombardment continued the whole day ; on the night between the 19th and 20th there was occasional firing ; on the 20th it again continued from morning till evening ; that night there was very occasional firing, and on the 21st again there was a continual bombardment from morning until the beginning of the night assault. Thus the bombardment leading up to this assault lasted for more than two periods of 24 hours and the assault resulted in the capture of the two Panlung redoubts.

In the bombardment which preceded the assault on the Aqueduct redoubt, firing was continued for a complete period of 24 hours on the 19th, and on the 20th the assault commenced which was repulsed. In September, before the assault and capture of the Aqueduct redoubt, the bombardment lasted only 12 hours. There were many other instances of the duration of bombardments.

In all the frequent assaults on the various smaller works and trenches the bombardments were less severe, lasting generally for about two hours. In these the enemy directed his fire not only on the point on which the assault was to be directed but also on the neighbouring works, on all the batteries, over the roads leading to the attacked front, over the

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places where it was supposed that our reserves were hidden, and even on all ravines lying in rear of the threatened neighbourhood. Guns of all calibres, whichever the enemy could bring to bear in the required direction, took part in the bombardment; and while some guns were firing common and high-explosive shells others were firing shrapnel.

In spite of the generally-accepted opinion that an attacking enemy must stop firing when his columns arrive within 200 paces of their objective, the Japanese did not cease firing at that time but kept it up until there remained between the columns and the fortification not more than 30 to 50 paces, and then concentrated their fire on the interior of the work. At Fort Erlungshan the Japanese continued their fire even later than this, until they had even crowned the glacis and constructed on it a number of their own trenches; but it was actually observed that occasionally, though only rarely, they hit their own men. The combined action of the artillery with the storming columns was most important, because, by the time the enemy ceased firing at the parapets, only an inconsiderable distance remained between them and ourselves, and because, *by the time we had succeeded in hauling the guns for opposing assaults from their shelters up to their emplacements by means of the ramps, the enemy were already protected by defensible epaulements.*

It is evident that the method of providing for the guns specially intended for opposing assaults has been imperfectly considered. To leave them unprotected would be impossible, as in that case they would be very soon disabled; and to bring them up during the continuance of the artillery fire is also impossible as it would prove fatal to the gun detachments.*

I think that guns for opposing assaults must either be immovably fixed in permanent concrete casemates or armoured turrets, or else mounted on disappearing turrets with very thin armour.

The effect of modern quick-firing artillery is so great that, if it can be made possible to keep in a fort or other work guns suitable for opposing assaults and to have them ready for action when the attack arrives within 500 to 600 paces from it, then it is certain that the enemy, no matter how persistent he is, will not be able to face their fire and must fall back. But to preserve the guns from destruction and to give them the power to act when required can only be done by one of the arrangements mentioned above or by modifying the construction of the existing shelters.

Thus in the attack which has been described the enemy, under cover of his artillery, brought up his columns so close to the attacked works that the infantry of the garrison had barely time to give him two or three volleys before his troops rushed in with the bayonet, and the result depended on the quantity and quality of the troops.

During the siege of Port Arthur both sides used hand grenades in large quantities. These grenades created a great impression on both sides, but everything points to the fact that this measure was only a makeshift and that the proper means of opposing an assault is the provision of guns and machine guns kept for that special purpose.

F. E. G. SKEY.

* This difficulty of bringing up the guns was met in the end by our refusing to put them in the shelters, and they were left in the open at the risk of being prematurely disabled.

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REVIEW.

REPORT OF THE INDIAN SURVEY COMMITTEE, 1904–05.

(Folio. Simla.)

THIS Committee was appointed by the Government of India to report on certain points, the most important being:—

(1). The state of the maps in each Province, and the measures required to bring them up to date.
(2). Methods and expense of survey.
(3). Methods of reproduction.
(4). The organization of the Survey Department.

The Committee consisted of:—

President.—Mr. J. O. Miller, C.S.I., I.C.S., Secretary to the Government of India (Revenue and Agriculture).

Members.—Colonel Sir John Farquharson, K.C.B., R.E. (retired), late Director General, Ordnance Survey.
Lieut.-Colonel F. B. Longe, R.E., Surveyor General of India.
Colonel F. H. Kelly, R.E., A.A.G., General Staff, India.

The time at the disposal of the Committee was short; but they managed to collect evidence and to produce a report which is full of interest, not only to officers employed in the Department concerned, but to the Corps at large, seeing that one of the recommendations made was for the employment of 70 imperial officers instead of 40 as herefore.

The following appears as a Summary of the Recommendations made. I have added some comments in italics.

"(1). The preparation of a modern 1-inch map of India should at once be undertaken. [*For considerable areas ½-inch or ¼-inch would suffice, and save expense.*]

(2). This work should be regarded as the most important now before the Department.

(3). The direction of operations should be strictly Imperial, and local authorities should not be allowed to intervene.

(4). The Surveyor-General himself should directly control the operations with the staff proposed in the report.

(5). The operations should be conducted on the lines laid down in Sir John Farquharson's scheme printed as Appendix B to the report.

(6). The whole of India should be divided into tracts, each of which should be allotted to a Survey party, for which a definite programme should be laid down, that should not be departed from without grave

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reason, and then only under the orders of the Government of India. The number of topographical parties should be fifteen. [*These should be grouped under circles for decentralisation, as recommended by Surveyor General.*]

(7). The departmental programme should extend to the whole of India and 25 years should be allowed for its completion.

(8). Special arrangements should be made for the completion of the work required near the North West Frontier within a period of 4 to 6 years.

(9). In the course of the 25 years' programme all topographical maps should be brought up to date. There should be no further correction (except for the addition of new railways and canals) until the next systematic revision of the maps of India is undertaken.

(10). Cadastral and other large scale surveys should be left entirely under the control of Provincial Governments and Local Authorities, and should be conducted at their expense, but should be based on a scientific skeleton or traverse. [*This arrangement very expensive, and unsatisfactory for uniform quality.*]

(11). Special forest surveys should cease as a general rule, and, where required on scales larger than the regular topographical ones, their cost should be debited to the Forest Department. [*Forest surveys directly remunerative, and necessary.*]

(12). For mapping purposes the most important classes of work in the Trigonometrical Branch are triangulation and levelling, and to these the more purely scientific work of this Branch should give way, if there is any difficulty about sufficiently increasing the staff. [*Scientific work always pays well eventually.*]

(13). The question of handing over tidal work to the Local Authorities concerned should be considered.

(14). The Government of India should prescribe the general and special maps which it is to be the duty of the Survey of India to produce.

(15). The form of the topographical maps should be permanent.

(16). The standard sheets of the 1-inch map should be reduced to half their present size.

(17). The scale of survey should, as a general rule, be at least double the scale of publication, and the latter should ordinarily be not less than 1 inch = 1 mile.

(18). The symbols used on the maps should be uniform throughout, and the modern spelling of names should be adopted.

(19). The number of trigonometrical and clinometrical heights and levels shown on the maps should be largely increased; but first all the main lines of levels should be equated.

(20). The vertical interval between contours is a matter requiring attention.

(21). The 1-inch map should be printed in four colours, black for the detail, brown for the hills, blue for water, and burnt sienna (or lake) for the roads.

(22). The topographical maps issued by the Survey of India should contain only information verified by its staff.

(23). Village boundaries should not be shown on the ordinary topographical map.

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(24). An edition of the 1-inch map may be prepared showing village boundaries under certain conditions.

(25). For the production of the 1-inch map an improved process of helio-zincography should be employed, a few selected standard sheets being engraved on copper.

(26). The Atlas of India sheets should now be superseded by "Degree" sheets on the $\frac{1}{4}$" scale, which should be engraved on copper. [*Engraving too expensive and slow?*]

(27). In the place of the $\frac{1}{1\,\frac{1}{8}}$-inch Provincial maps a general map of India on the scale of 1 : 1,000,000 should be prepared and engraved.

(28). To leave the Surveyor General free for the supervision and control of the operations, the Deputy Surveyor General should deal in the first instance with the business of all kinds of the Survey Office, and should dispose of all matters of routine. He should be allowed an Assistant, and the post of Assistant Surveyor General in charge of the office will then be unnecessary.

(29). To assist him in inspecting the field parties the Surveyor General should be allowed an inspecting officer.

(30). Surveys towards or beyond the frontier should be treated specially, and be placed directly under a Superintendent of Frontier Surveys occupying a position similar to that of the Superintendent of Trigonometrical Surveys.

(31). Owing to the abolition of special forest surveys, the post of Superintendent of Forest Surveys should lapse.

(32). The Trigonometrical Branch should be strengthened by two officers to assist in triangulation and levelling.

(33). The strength of the field parties should be increased by 50 per cent.

(34). There should be two officers, one in charge, the other his assistant, with each ordinary topographical party.

(35). With the frontier parties there should be three officers, one in charge, and two assistants to allow for special calls.

(36). To meet these proposals the staff of the Imperial Service for topographical and trigonometrical work should be increased from 40 to 70 officers.

(37). First appointments of officers of the Army to the Imperial Service should be for a term of five years only and a language test should be imposed.

(38). The Provincial Service should be divided into two Services, a Provincial or Indian Service, and a Junior Service; the pay of the former to range from Rs.250 to Rs.800, and that of the latter from Rs.80 to Rs.400; and some modifications in the system of recruiting should be introduced.

(39). Natives of India should continue to be employed in the Provincial and Junior Services in the proportions stated.

(40). Officers in charge of parties should have a free hand to enlist surveyors, and parties should recess in the neighbourhood of their charges.

(41). Imperial and Provincial officers employed on cadastral or similar work should be treated as temporarily outside the regular cadre, and the

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Surveyor General should be authorised to employ other officers in place of those so deputed.

(42). The supervision in the Photographic and Lithographic Office should be strengthened by the appointment of an additional officer as assistant to the officer in charge. The superintendence of the Mathematical Instrument Office should be placed under these two officers.

(43). The first duty of the reproducing offices should be the production of the maps of the Survey of India.

(44). No drawing of extra-departmental work should be permitted to be thrown on the Survey of India office. [*Is this feasible, or desirable if proper regulations and financial rules are made to control such work?*]

(45). Local Governments should reproduce their own cadastral maps.

(46). As the reproduction of the revised topographical maps throws more work on the headquarters office, arrangements should be made to gradually transfer extra-departmental work to other Government mapping offices.

(47). Certain improvements should be introduced in the methods, working, establishment, and plant of the reproduction offices.

(48). Seeing that the general revision of the topographical map of India is being commenced, the publication of maps compiled from obsolete material should cease. [*Temporary maps better than nothing.*]

(49). To facilitate the supply of maps to the public and to officials, up-to-date catalogues and index maps should be freely issued.

(50). The form of the Survey budget should be simplified, and better financial control instituted within the Department.

(51). An attempt should be made to devise more definite standards of work in order to check out-turn and cost.

(52). The annual programme should be discussed with the Surveyor General by a Board or Committee representing the different departments of the Government of India.

(53). The proposed removal of the headquarters from Calcutta should be postponed for the present.

(54). Greater attention should be paid to the preservation of all permanently marked survey points." [*Is this possible under the centralised organisation proposed?*]

The meaning of these proposals cannot well be understood without a study of the Report as a whole, more especially as the member of the Committee best acquainted with Indian conditions, the Surveyor General, dissented from them in vital particulars.

It is necessary to mention that the Committee found the state of the topographical maps to be in an unsatisfactory condition and the methods of reproduction not all that could be desired.

The maps themselves showed a lack of some definite standard as regards quality, and important districts appeared to have been neglected for work of less urgent nature elsewhere. This result is ascribed to the want of a definite central policy in dealing with all classes of survey for the country as a whole; consequently local interference was able to exercise a deleterious effect, and fitful reductions of establishments were made by the Imperial Government.

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The Committee was, therefore, faced with a vast problem, comparable in kind to that of Army Reform. The same radical questions required an answer, and the decision which the Government of India is now called upon to give is one of much gravity.

These questions are:—

(1). What should be the functions of the Survey of India?
(2). What should be its organisation to carry them out?

It will be seen that they involve a wider scope than was included in the term of reference to the Committee, and may be said to arise out of the result of its labours which demonstrated that such questions required an answer. For this reason the recommendations of the Committee become automatically out of date; although their labours retain their full value in information collected in the Report.

An endeavour will now be made in the short space at disposal to indicate the chief considerations of main policy which appear to suggest themselves from the new standpoint. These will naturally differ from the recommendations of the Committee.

The possible functions of a Survey Department comprehend a very wide range; viz., from such highly scientific activities as geodetic work or magnetic surveys to the actual letting of government lands to settlers (New Zealand Survey) with the appraisement of agricultural and mining values, legal titles, and other matters merging into the functions of a Department of Agriculture. The whole forms an edifice the value of which as such depends on the quality of its parts, but more particularly upon its foundations. The scientific part of survey comprises the foundations. As with buildings, these are apt to be scamped by the jerry builder; because they are unseen, or because their uses are not understood by the ignorant, whose knowledge only extends to the uses of the rooms above. Or, we may regard it as a good example of the metaphysical idea, the incarnation of wisdom, the scientific idea descending through various stages, becoming more and more visible in material uses from primes to ultimates. Thus, the practical uses of highly scientific work are not apparent to the man in the street; then comes triangulation, with the small scale or topographical maps recognised as useful for military and general purposes by a considerable number; whilst the ultimate stage of large scale cadastral maps, to be used for administration, land transfer, building, etc., has uses patent to all.

Whilst the history of survey in various countries furnishes examples of the fatal policy of jerry building, of trying to provide the "rooms" of cadastral maps without any but the skimpiest "foundations" of triangulation; so there is a danger amongst scientific surveyors of underestimating the real urgency for cadastral maps to meet the practical, political, and commercial needs of a community. It is the *rôle* of the statesman to control extremists, and to see that a Survey Department is charged with, and organised to provide, both the scientific foundation and the cadastral plans in addition to topographical maps. The provision of good topographical maps for military use and general purposes is, doubtless, the most important requirement. The Committee's desire

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that the 1-inch and smaller scales should be pushed on with energy will be generally endorsed ; whilst an outside suggestion for a larger scale map for military use may be ruled out, because the distribution and storage to the extent required is impracticable in the case of large scale maps.

It would be a most questionable policy for the Government of India to adopt the recommendations of the Committee in so far as they advise that the Survey of India should practically throw over cadastral work, and concentrate all attention on the completion in 20 years of the topographical survey. This is recommended because the small scale maps are so backward, and because the attempt to deal with them and odd portions of cadastral work together has had such unequal results. But, the reason plainly discernible in the evidence is not, as assumed, due to one department doing both classes of work, but to the fact that the organisation of the Department was unfitted to deal adequately not only with both together but with either singly.

The broad fact remains that when once the triangulation is done, it can be used as the basis either for a topographical survey or for cadastral survey. There is no reason whatever why a Survey Department should not then be organised so as to be capable of dealing concurrently with the most urgent demands in each branch. No other organisation can be based on principles of continuity and economy; for as soon as the original topographical maps are completed, and only periodical revision remains, the activities of the survey personnel must largely be transferred by degrees to cadastral work. The concurrent working in each district of both kinds of work enables the staff to be gradually trained in cadastral duties as the proportion of this class of work expands and topographical work diminishes. This is the natural progress of a Survey Department from youth to old age. To confine it to topographical work is to ensure its extinction in middle life.

Another cogent reason for furnishing the Department with a complete constitution and functions is that forest and cadastral work carried out properly, as they then would be, can be utilised to assist topographical work.

The Government of India is peculiarly *in loco parentis* to the people; and it is inconceivable that such an essential requirement as good cadastral maps, urgently needed by localities, should be thrown to the winds as something to be obtained anyhow and of no concern to the Imperial authorities. Indeed, political expediency would appear to add its claims to paternal duty in support of a policy of providing local survey establishments, in moderation, to cope not only with local government and municipal needs but also with private work on repayment.

It is a mistake to suppose that such a policy involves a greater imperial expenditure or less progress in the imperial work of topographical survey. There is, indeed, no reason, given a suitable organisation and financial system, why the inclusion of cadastral work should not cause a saving of imperial funds. Cadastral work is essentially work for which those who want it should pay. They are always willing to pay a government department, owing to the great cheapness and excellence of its survey compared with what can be obtained outside. Hence, with a Department organised suitably, decentralised into local centres with power to enlarge staff and

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plant, like any business concern, up to outside demand and payment for goods, the expenses of both staff and plant can be adjusted to the orders normally given. The topographical work can go on independently in each district up to the limit of imperial funds. Such a conjunction of the two in each centre, not too remote to be in touch with its area, is beneficial to both through the give and take in staff that can be made to meet fluctuations in demand, the loss arising from such fluctuations being practically wiped out by this arrangement. With a centralised organisation, such as now exists and is proposed to be retained by the Committee, it would be impossible to work on such business lines.

Much may be said, therefore, in support of the suggestion of the Surveyor General to institute a decentralised organisation of local centres. Reasons have been given why cadastral work should be efficiently provided for in such a scheme, a consideration which must raise the number of local establishments to 8 or 9 in the first place, eventually to more. The cost of providing such will be considerable; but as they will chiefly be required for non-imperial work, this cost should eventually be recovered from the payments for cadastral work. It appears only necessary to include a charge sufficient for a sinking fund to meet capital advanced and interest. Each District could be debited with a debt to pay off, a system which would make the local survey officer chary in his demands for capital expenditure beyond the scale of local business. It would also furnish a continual check to the Imperial Government on the principle of keeping all cadastral work self-supporting. This is most necessary; for, if it would furnish the above check on undue expenditure in some localities, it would also show clearly others where such demands should not be refused because obviously justified.

The Survey of India has always deservedly held a great reputation by reason of the high excellence of the scientific work of its officers, and the resource and energy shown under difficulties in frontier surveys and other operations assigned to its staff. Such a distinguished personnel should have its energies directed by an organising and business capacity of a corresponding order. It should not suffer, even by a misunderstanding of the circumstances, from the imputation of partial failure to reach satisfactory results. The very best staff of experts cannot make a business successful unless their energies are co-ordinated and directed to a definite end by a competent system of management.

The decision of the Government of India in this important matter of the future of the Survey of India will be awaited with much interest; for this department as constituted at present, does not offer, as the Surveyor General himself remarks, an attractive prospect to ambition. Still less will it do so, if, in future, its operations are to be confined to topographical work entirely and under a centralised system of administration. Apart from the consideration of efficiency and economy, to which undue centralisation is opposed in practice, such an organisation offers little field of activity to the higher ranks; and the supply of suitable officers of the large numbers required, all experienced, but of junior rank in extreme proportions, is not likely to be obtained without great difficulty.

E. P. BROOKER.

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NOTICES OF MAGAZINES.

Bulletin of the International Railway Congress.

March, 1906.

Armoured Concrete in Railway Work in Russia.—The Russians would appear to have been by no means behindhand in availing themselves of this system of construction; and in this article there are some useful descriptions of works carried out on the various railway systems, detailing also their mode of construction, methods of casing and centering and leading dimensions, together with numerous illustrations, such as might be useful for reference. Among the works described are:—Locomotive shed roofs, water reservoirs and tanks, buildings of various kinds, culverts, foundations, and viaducts.

Certain ice-houses and vaults for paraffin strike one as particularly interesting, as these structures, covered over as they are with earth, are much of the nature of small magazines, and a similar method of construction for stores to contain explosives might on occasion be both suitable and economical.

In this connection one may mention that a large terminal station has recently been erected at Atlanta, Georgia, for the Southern Railway, U.S.A., constructed throughout in reinforced concrete, and including among other features some retaining walls of rather interesting design.

C. E. Vickers.

Engineering News.

April 5th, 1906.

Construction Work on the Canadian Northern Railway.—This line has now a considerable system, some 2,500 miles, extending from Lake Superior to the North West, where settlement is now taking place very rapidly. Between March and November, 1905, some 400 miles of line were laid up to Edmonton, and work has since been continued westward

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as weather permitted. The soil being easy, a soft black loam underlaid by clay or gravel, it was possible to make the formation mainly with drag-scrapers, use of steam shovels being only occasionally necessary The culverts are of timber, squared for the sides, top of cross logs notched to fit.

Track laying was worked by a train consisting of a "pioneer" car leading, then flat cars of rails, then the engine followed by cars of sleepers and bridging material. The rails were run forward along roller ways at the sides of the cars and the sleepers carted (about 50 teams being employed, averaging about 25 sleepers to a load). Spiking and fishing were completed close behind the train. The leading "pioneer" car was provided with a high platform from which signals could be given to the engine.

A tracklaying gang, to do 3½ miles per diem, 7 a.m. to 6 p.m., was made up as follows :—

In front of engine.	*In rear of engine.*
1 foreman.	1 foreman.
8 rail pullers.	24 spikers.
2 line men.	12 bolters.
14 sleeper men.	6 nippers.
4 spikers.	3 spike distributors.
2 nippers.	1 putting in bolts.
18 steel men (handling rails on both sides of car).	1 water boy.
	6 liners.
1 liner.	6 sleeper men.
1 gauge man.	80 men handling sleepers, including teamsters.
1 sleeper marker.	
4 bolters.	1 blacksmith.
4 loading rails on trollies.	2 cooks.
	4 helpers.
	1 time and storekeeper.

Total 208.

Sidings for material trains were put in about every seven miles.

C. E. VICKERS.

MITTEILUNGEN ÜBER GEGENSTÄNDE DES ARTILLERIE-UND GENIEWESENS.

March, 1905.

A MINIATURE RANGE.—A short account of a range erected on the exercising ground of the Railway and Telegraph Regiment may prove interesting to R.E. officers, who often have to supervise the erection of such ranges at home.

It will be seen that the Austrians spend considerably more on their

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ranges than is usual in England; and they are provided with every form of target.

The range described has an extreme length of about 37 mètres measured from the centre of the firing point, and is 14½ mètres wide.

Accommodation is found for 12 men to shoot simultaneously; and the firing point, instead of being merely a platform, consists of a shelter trench with covered loopholes 90 centimètres apart. For half its length, that is for six loopholes, the trench is for fire kneeling, and for the other half for fire lying down. The sides and bottom of the trench and the interior slope of the parapet are lined with boarding in order to increase their stability and also to save the uniforms of the men firing. To enable shooting to be carried on irrespective of the weather, the whole firing point, with the machinery for working the targets, is roofed in, forming a shed some 14½ mètres long and 7 mètres wide.

The range itself consists of four small butts at different distances from the firing point, as shown in the longitudinal section. On each of these butts are fixed two targets.

On the first three butts the targets are simply vanishing targets that can be lowered or raised from the shed over the firing point by means of connecting wires. The targets also fall when struck by a bullet. On the fourth butt are two moving and vanishing targets which have a lateral motion along the edge of this butt.

In rear are two advancing targets. Thus in one range every variety of target is provided.

All the targets can be worked from the firing point by one man; but if several are to move simultaneously a second man is required.

From each target wires run to posts on the left side of the range and from these posts they run over pulleys to the firing point, where there is a separate wheel and handle for each target. There is a notice above each wheel showing to which target it is connected. When the targets are lowered they are concealed from view by the butts.

The working wires, when they leave the posts on the left side of the range, are taken well below the top of the butt so that they cannot be injured by bullets. Each wire is provided with a 'tightener,' so that any slackness in the wires caused by change of temperature can be promptly remedied.

An idea of the mechanism of the first five targets can be obtained from the accompanying section and elevations.

The wooden lining of the reverse side of each butt is supported by strong posts, 10 c.m. × 10 c.m., and to these are screwed iron brackets (*z*) which are connected by an iron bar (*w*).

The position of this bar is secured by an iron filling piece inserted between the bracket and the bar. This also serves the purpose of regulating the height of the bar so that the targets when laid back are the proper height. On the brackets (*z*) are the bearings (*m*), carrying the roller (*r*), to which the figures (*x*) are fastened by means of hinges (*s*).

The figures are made of strong iron plate, 5 millimètres thick, as anything thinner is found to break very quickly. To keep them in their

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proper positions a flat spring (*i*) is used, screwed at one end to the hinge, and pressing at the other end on the roller which is filed flat to receive it; in this manner a certain resistance is offered to the falling of the target.

The roller is turned out of a bar of iron 22 millimètres square. At its centre point it is squared to receive a two-armed lever (*b*). The arms of the lever are connected by rings and spring clips at (*f*) and (*g*) with the wires which work the target.

The movement of targets 1 to 6 is accomplished as follows:—

The wire *f* is tightened by turning the proper wheel at the firing point, and one arm of the lever (*b*) is drawn downwards; the roller is turned through an angle of 90°, and the figures are thus raised into position.

If the handle of the wheel is turned in the opposite direction, the other end of the lever is pulled by the second wire *g*; in this way the roller is brought to its former position again and the figures are lowered.

The figures knocked over by bullets are restored to their natural position by the force of impact, as the spring presses on the flat place in the roller and so brings the figures back into their proper position.

Removable wooden covers are fixed to all the targets in order to protect the mechanism from the weather. These covers are made large enough to allow of the targets being raised while they are on. It is found that with these covers the range may be exposed to bad weather, the whole winter without suffering any material damage.

The moving targets 7 to 10 are rather more complicated, and would require too much space to describe in detail as they combine a vanishing target with a moving target.

The provision of spring clips to connect the wires with the levers of the targets is claimed as a great advantage, because the targets can be so easily connected and disconnected whenever it is necessary to supply a new wire.

In the maintenance of this contrivance it is principally necessary to thoroughly grease all parts exposed to friction, and when there has been heavy rain to clean any rusty parts and then grease them.

In dry weather the ramps of the butts should be well watered, to prevent the dust thrown up by the bullets getting into the mechanism of the targets.

As regards the time and material expended on the construction of this range the author gives the following information. The mechanical parts were executed by 5 smiths (including fitters) and 1 joiner in 21 working days of 8 hours each, but this did not include putting the parts together on the site. The earthwork, including the erection of the four butt walls and the main stop-butt was carried out by a working party of 30 men in 4 working days of 8 hours. The erection of the hut at the firing point was carried out by 1 N.C.O. and 10 pioneers, mostly carpenters; its entire construction, with the provision of tables, benches, and arm-racks took 10 working days of 8 hours. The fixing up of the different parts was carried out by the 5 smiths and the joiner in 8 days.

The total cost, using old material as far as possible, was 2,500 kronen.

C. OTTLEY PLACE.

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NATURE.

April, 1906.

"MAST AND SAIL IN EUROPE AND ASIA" (*p.* 536).—Mr. Warington Smyth describes this volume as an attempt to record the peculiarity of the principal types of sailing craft in Europe and Asia, and to consider the causes which have been at work in the development of boats, and the results attained under the conditions with which they have had to contend. For many classes of sailing vessels he gives the lines and the sail plans. Half the book is devoted to European types, beginning with the Baltic and Scandinavian countries, and passing to Holland, Scotland, the east coast of England and the Thames Estuary, the south and west coast of England, and then to France and the Mediterranean. Dealing with Eastern vessels, including those of the Indian Ocean, the Malay Peninsula, the Gulf of Siam, and China, Mr. Smyth finds special types of great antiquity differing widely from Western vessels, but well adapted for their special services and surroundings.

The degree of civilisation of any race is remarkably reflected in its boat architecture, and in maritime races this has always been marked by activity in boat building and by variety of design and rig. In no case has this been more notable than in the history of China and of Holland, and in the Adriatic in the fifteenth century, in Europe during the last two centuries, and in the United States since 1780. The Negro, the American Indian, and the Slav, on the other hand, have never designed a seagoing boat or cut a sail. It has not been for want of waterways or of opportunity; it has been simply owing to a lower class of intelligence and to want of originality and enterprise. This book should find a hearty welcome from all who love to sail the seas and manage their own craft.

HOAR-FROST IN THE MOON (*p.* 569).—A series of measurements of the bright spot around the lunar crater Linné were made at Harvard Observatory during the total eclipse of the moon on 8th February. These results show that the diameter of the spot began to increase as Linné passed into the earth's shadow, and to decrease rapidly on a return of sunlight to that portion of the moon's surface. Professor Pickering considers that this phenomenon is due to the formation and melting of hoar-frost.

"ROWING AND TRACK ATHLETICS" (*p.* 605).—From the British sportsman's point of view this book will be read with pleasure, for it shows how eagerly the Americans have strived, and not in vain, to equal the prowess of the athletes on this side of the Atlantic. From the scientific point of view it is also of value, for it shows the evolution of ideas which have culminated in the present methods. The successful oarsman is he who is able best to combine a number of variables. These include personal fitness, easiness of style, length of oar and width of blade to suit his particular capability, length and weight of boat, and alertness of brain to take advantage of prevailing conditions and unforeseen eventualities. In

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many national characteristics climate plays an important part. The British style of rowing has been evolved under British weather conditions.

In track athletics the same principle holds, and this is borne out by the fact that, on the average, the American is the fastest sprinter, while the Britisher is the best at long distances.

THE SAN FRANCISCO EARTHQUAKE (*p.* 609).—The first series of preliminary tremors reached the Birmingham seismograph at 1h. 25m. 3s. p.m. 18th April; they were small in amplitude and had an average period of 6·4 seconds. At 1h. 35m. 7s. a second series much larger in amplitude and with a period of 11·4 seconds were registered. These tremors traverse the body of the earth with varying velocities of from 10 to 4 k.m. per second. The end portion of the disturbance began at 2h. 1m. 4s. and consisted of a long series of unusually clear and regular waves with an average period of 15 seconds. Another series of long low undulations from 4h. 58m. 32s. to 5h. 6m. 34s. represent the return of the first series of surface undulations, after they had completed the tour of the globe and travelled once more as far as Birmingham. They did the journey in 3h. 10m. 19s. with a mean velocity of 3·36 k.m. per second. The mere fact that the earth waves should disturb a seismograph after thus travelling 30,000 miles shows that this earthquake belongs to the very front rank, inferior, perhaps, to the Lisbon earthquake of 1755 and the Indian earthquake of 1897, but in the same rank as the Japanese earthquake of 1891 and the Indian earthquake of 1905.

W. E. WARRAND.

OESTERREICHISCHE MILITÄRISCHE ZEITSCHRIFT.

March, 1906.

PRACTICAL EXPERIENCES OF SPADEWORK IN THE ATTACK.—The experiences of the recent war in the Far East have shown that under certain circumstances the provision of artificial cover may be as valuable to the attack as to the defence.

The Austrian military authorities appear to have thoroughly recognised the truth of this; and in April, 1905, the General Commanding the 11th Corps issued to all the troops in his command certain provisional instructions which may be summarised as follows:—

Spadework in the attack has, as its most important object, the construction of covered positions on open and exposed ground, where it is a question of definitely securing the possession of ground already won, and of enabling the firing line, once installed in these positions, to hold them with comparatively slight loss against the fire of their adversaries until a renewal of the attack is practicable.

The soldier must therefore be well schooled in entrenching himself during a fight as rapidly as possible, keeping in a prone position.

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As a rule only half the personnel should be provided with shovels, so that every alternate man may entrench himself whilst the remainder continue firing as circumstances may require. These latter entrench themselves as soon as the others have commenced firing from their completed cover.

In this way a number of independent shelter trenches are provided within the beaten zone, that give at least protection against rifle fire. It is of course obvious that every advantage must be taken of the contour and natural cover of the ground when making these trenches.

The type of such trenches cannot be laid down by any hard and fast rule, and the illustrated examples given in the text are only to be regarded as types suggested as likely to be suitable.

The cover must, however, offer real protection; and therefore in ordinary soil the thickness of the parapet at the top should not be less than 1 mètre.

The trench must be adapted for comfortable shooting, and the oblique position of the body when shooting from a prone position must be allowed for.

"The first spadefuls are taken as shown in *Fig.* 1, the digger taking the earth from both sides and in front of him, and making a parapet of it; the earth on the surface, which is generally the firmest, being used to form a revetment for the interior slope.

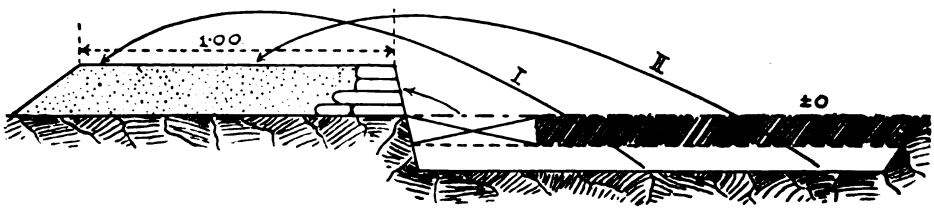

Fig. 1. 1/25

The first piece which is excavated at the commencement of the task and which is used to form the interior slope of the parapet; it also serves as a screen for the continuation of the work.

The first task of the trench; taken out from front to rear, so that the earth from the rear portion is thrown to the inner side of the parapet (II) and that from the front portion to the outer or far side of the parapet (I).

Completion of the trench, working from rear to front.

"The earth taken from in front should be thrown to the far side of the parapet, and that taken from the rear to the near or inner side.

"These exercises should be executed for the most part during company training.

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"The first object aimed at should be the instruction of the individual; later on they should be practised in sections; and if the size of the ground available for the purpose permits, in still larger parties."

The above instructions were issued when only the fact that the Japanese had successfully used entrenching tools in the attack was known; but the more complete knowledge obtained later in the same year served to substantiate the value of their teaching.

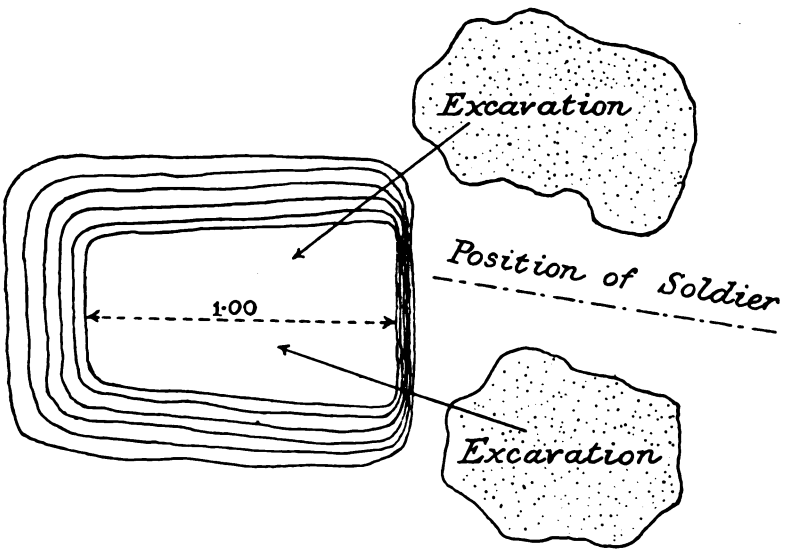

Fig. 2. ½5

The following is a summary of the chief points of information and practical experience gained in carrying out these exercises with entrenching tools:—

DESCRIPTION OF TRENCH, ETC.

Of the four types given as examples, Types I. and IV. had each their peculiar characteristics, while Types II. and III. were simply variations of Type I.

In Type I., the man entrenching himself takes the earth for the parapet from in front and from underneath him, corresponding to the position of his body as he lies to shoot, and throws it straight in front of him. The trench thus formed serves him at once as a sunken position to fire from. His cover is obtained from the trench and parapet combined. The process of the work is explained in *Fig.* 1.

In Type IV. the man remains lying on the natural surface of the ground and obtains earth by scooping holes on one or both sides. This earth he throws obliquely to his front to form a parapet (*vide Fig.* 2).

His cover thus consists only of a heap of loose earth, as the holes give no protection but only supply material.

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Very slight movement, besides turning from one side to the other, is necessary to get out the earth.

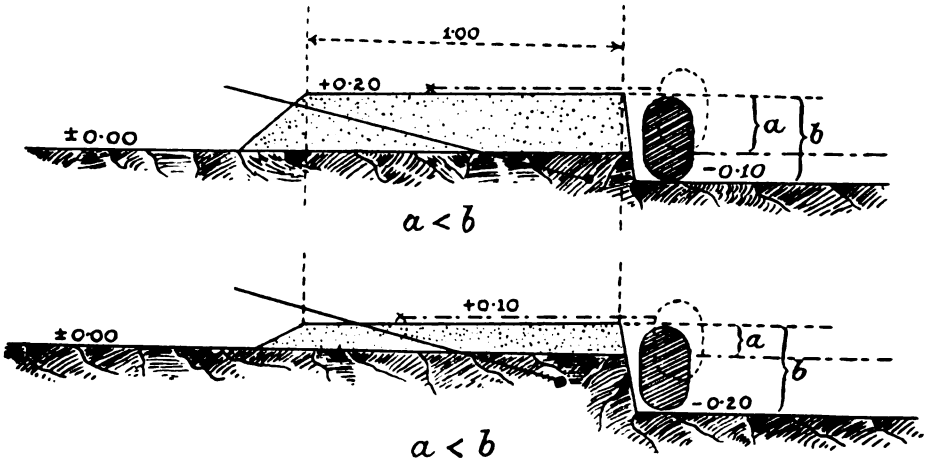

Fig. 3. ½5

Type I.

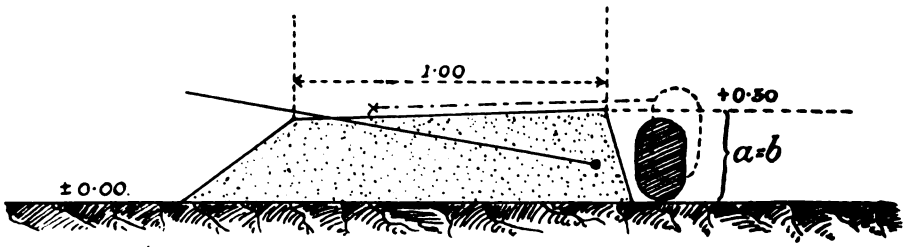

Fig. 4. ½5

Type IV

Height of Parapet *a.*

Depth of Cover *b.*

Type I.—Advantages.—It complies best with the chief requirement of a trench, that is it enables the man to cover himself from the sight and fire of the enemy as quickly as possible.

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As the cover provided is a combination of excavation and heaped-up earth, it follows that the parapet rises very little above ground level and so forms a very small mark for the enemy's fire.

Less earth is required than in Type IV. and it is therefore more quickly completed. The resistance of the parapet is greater as the lower portion is solid earth.

Disadvantages.—The trench to be dug is very long from front to rear, requiring considerable movement in the position of the body; and the excavated earth has to be thrown further than in Type IV.

Type IV.—Advantages.—Requires less bodily movement than Type I.; and the holes from which the earth is taken may be utilized at a later stage in the construction of cover for other men.

Disadvantages.—It is some time before cover is obtained, as the man remains on the surface of the ground.

The parapet for the same amount of cover as Type I. has to be taken much higher, and offers a better target for the enemy's fire.

The earth to be dug out is nearly twice as much as in Type I.; and the parapet, consisting entirely of loose earth, has less resistance.

A comparison of the two types is therefore all in favour of Type I.

It is very difficult to decide whether it is more practicable to obtain earth for the parapet from holes dug on each side as in Type IV. or from trough-like trenches dug to suit the position of the body. It must depend for the most part on the capability of the man and the nature of the ground.

With a view to solving this question, some interesting experiments were made in a Militia Regiment.

A party of men were formed into a firing line, and were told that they were under very heavy fire and that they had to entrench themselves whilst lying down. Nothing was said as to the type of cover, and everything was left as much as possible to their own instinct.

It was found that they all corresponded in the main to Types I. or IV. It was noticed also that many of those who began by taking earth from holes on each side soon of their own accord gave up this method and copied those who were digging the earth from underneath them. In point of fact this Regiment (XI.) took more than twice as long over Type IV. as over Type I.

It is obvious that the left-handed hole in Type IV. is very awkward for a right-handed man; and his efforts to get earth as near his parapet as possible, and without too much movement and turning, generally result in his working only on his right side and getting out a deep and narrow hole, which has no value either for his neighbour in the firing line or for the supports in rear when they come up.

This objection would be abolished by the following method of construction (*Fig.* 5). The man entrenching himself takes the earth for his parapet from a long shallow ditch on his right side (if he is right handed); this he can do by extending his arms when working, and by a sliding motion of his body. The first portion excavated is used to make a steep interior slope for his parapet, and this serves at once as a screen. On completion he gives his shovel to the man on his right, who has hitherto

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been firing, and opens fire himself. The right-hand man crawls to his left into the shallow trench (1), and enlarges it into a trench for firing from a prone position (2), similar to Type I.

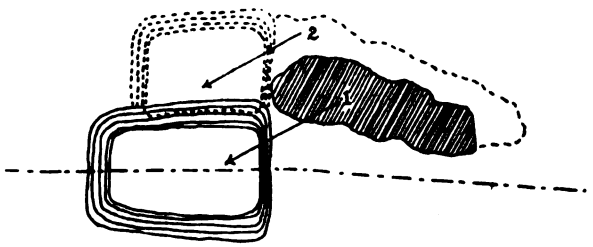

Fig. 5. 1/50.

In cases where the right-hand man has made his cover independently, these flat trenches could be utilised by officers or by the supports, and completed accordingly.

In some cases it appears to have been reported that Type IV. was undoubtedly superior to Type I. because in wet weather it was drier. But as any flat ground will be thoroughly wet after heavy rain, this objection is not sufficient to condemn Type I.

The author suggests some form of judicious drainage; but admits that time and opportunity would generally be lacking.

HEAD COVER.

A variety of views appear to be held on the subjects of head cover and concealment.

While fully admitting the value of head cover for trenches in the attack, it is argued that the construction of loopholes takes considerable time, and unless well and carefully formed they cramp the field of fire. Moreover the necessarily increased height of the parapet makes it a much more conspicuous target for the enemy's fire.

On the whole it seems to be the author's opinion that loopholes should not be provided, because in the attack the trenches should be as simple as possible in order that the cessation of fire on the part of each individual while he entrenches himself should be as brief as possible.

CONCEALMENT.

The necessity of taking every advantage of all natural and existing cover, when entrenching during the attack, is thoroughly recognised: but the provision of artificial concealment must be judged from a different standpoint.

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The best results as regards artificial concealment can only be obtained by a force acting on the defensive with plenty of time and a variety of material at their disposal. Screens of grass and straw and the artistic use of colouring material will often make the various defence works harmonise so completely and naturally with their surroundings that they are impossible to detect even at decisive ranges.

The occasions on which the attacking side could employ artificial concealment to similar advantage would however be extremely rare; and even if the best results were obtainable, the fact that the work would have to be carried out under the eyes and fire of the defence would render them useless. Concealment being therefore almost impossible, the attacking force must content itself with offering as small a target as possible to the enemy's fire.

On level ground where men can fire with their rifles at ground level (*i.e.* without any command) a parapet may sometimes be advantageously dispensed with. In this case the earth taken from the trench may be made into a false parapet (*Fig.* 6) to attract the attentions of the defence.

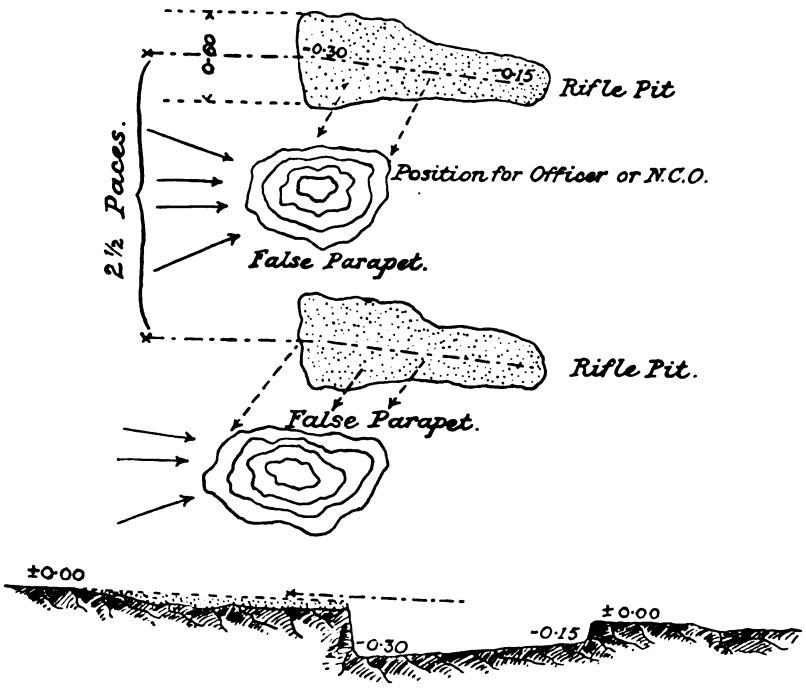

Fig. 6. 1/50.

It would be interesting to test by practical experiment the extent to which hasty trenches thus executed by the attacking force could be

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improved and completed during the fight as opportunity offered. Such an opportunity would occur when an indecisive battle was temporarily suspended during the night. Under cover of darkness the little individual trenches could be amalgamated into one strongly protected work and the attacking force would be much more favourably situated to continue the fight the next day.

METHOD OF CARRYING TOOLS.

Experiments were carried out by two Infantry Regiments with a view to deciding whether the present method of carrying the entrenching tools permitted of their being quickly unbuckled and taken into use and also tended to prevent their being lost.

According to the Austrian official instructions these tools are strapped to the man's valise or knapsack; but it appears that it requires the help of a second man to unbuckle them, and they also impede the man when marching.

Various suggestions are made for improving this; but they are of little interest to those who are not acquainted with the Austrian pattern of equipment.

CONCLUSION.

In order to clear up the differences of opinion which were noticeable in the reports of the units taking part in these experiments, and to form a correct estimate of the value of this kind of spadework, it is to be hoped that this problem will attract equal interest elsewhere.

Great as are the advantages of a proper use of entrenching tools in the attack, it must be borne in mind that corresponding precautions must be taken against the misuse of these strictly defensive weapons.

It must be remembered that the only road to superiority of fire, and at the same time the best protection against the fire of the enemy, is to be found in one's own fire; and therefore spadework must be the exception rather than the rule. But when the attacking force is at a disadvantage, and it is impossible to advance, whilst retreat means destruction, then it would be folly not to make use of such means of restoring strength and confidence as have stood the test of practical experience in the recent war in the East.

To lay down rigid rules for this sort of trench work would do more harm than good. The main point is in every case to find out the type most suited to the circumstances, and to stimulate and keep alive the men's intelligence and interest in this sort of work. Each man must thoroughly understand his tools, and how to use them in any combination of circumstances. A good shot who can also ply a good pick and shovel will instinctively do the right thing at any moment during the fight.

But this knowledge of the proper use of entrenching tools can only be obtained by careful instruction in peace time, accompanied by frequent practical exercises on a variety of ground. In this way his entrenching tools will be to each man what they are meant to be, that is a welcome

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and useful assistance, not only in defence but also under certain circumstances in attack; and they will never be regarded by him as so much useless extra weight.

Thus regarded, the construction of covered trenches in the attack can have no ill effect on the soldier's desire to get to closer quarters with the enemy; for he will willingly leave his cover to advance to the attack, if he knows that he possesses both the means and the skill to entrench himself equally well at the next halt. Thus relying on both rifle and spade, and energetically led by his officers, he will never forget that the reward of his work and his danger lies in the place which his foe occupies.

Working Time Table.

Regiment.	Time occupied in Minutes.					
	Type I.			Type IV.		
	Soil.			Soil.		
	Light.	Medium.	Heavy.	Light.	Medium.	Heavy.
I.	25—30	60—72[1]	—	—	—	—
II.	—	20—30	—	—	30—40[2]	—
III.	30	50—90	—	20	40—60	—
IV.	—	—	—	20	—	—
V.	9[3]	13[4]	18[5]	18[3]	27[4]	36[5]
VI.	13—20	—	—	13—20	—	—
VII.	10—20	30—45	—	10—20	30—45	—
VIII.	10	25	—	30	40	—
IX.	15—20	30—45	—	—	—	—
X.	12—15	18—22	—	—	35	—
XI.	10	15—20	—	25	35—40	—
XII.	15—20	—	—	—	—	—
XIII.	8[6]	—	—	10[6]	—	—
	16[7]	29—52[9]	90[10]	20[7]	45—60[9]	80[10]
	22—29[8]	—	—	15—20[8]	—	—
XIV.	5—6	10	18—20[11]	—	—	—
XV.	8—10	15—20	20—30	—	—	—

NOTE.—[1] Hard dry stubble field. [2] Pasture land with clay stratum and turf top soil. [3] Loam covered with 7 c.m. of turf. [4] Stiff clay. [5] Stiff soil, marl and chalk. [6] Sandy loam. [7] Sand and gravel. [8] Plough land. [9] Hard grassy ground. [10] Hard dry clay and stones. [11] Damp soil.

C. OTTLEY PLACE.

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RAILWAY GAZETTE.

March 23rd—30th, April 6th, 1906.

TRAFFIC STATISTICS AND FREIGHT TRAIN WORKING.—By W. Marshall, North Eastern Railway.—This series of articles is extremely interesting, as they cast a good deal of light on the actual employment of statistics in railway management, apart from those summarised figures which, communicated to the shareholders, enable them and others to criticise the management of their property. In this connection a remark may be made as to the extraordinary apathy of railway companies regarding the use of statistics in combating increased taxation. It is well known that the companies are pretty severely bled by the rating authorities.

The principal units employed up to the present are:—Wagon-miles (sorted according to loaded and empty, and by direction), engine-hours, train-miles, and ton-miles. None of these figures, however, are absolute or always based on equivalent units, for capacities of wagons vary, engines are not all of the same class, and tonnage has to be taken out laboriously from invoices, with the added complexities introduced by through traffic. Combinations of the above-mentioned units, such as 'wagon-miles per engine-hour,' are also taken out, and are doubtless valuable.

What the writer says about application of statistics goes to show that the more the figures are aggregated to show results over the whole of the line the less use they are for practical purposes. The figures which are actually useful are those relating to particular operations, enabling comparisons to be made from day to day; and so that they should be both available promptly and got out in a convenient form it is an advantage to leave their compilation in the hands of the local man.

When, however, the figures apply to operations controlled from headquarters, *e.g.* loaded and empty wagon mileage, the abstracting of the figures into more general totals is advantageous, provided they are all obtained in the same way.

We are inclined to come to the conclusion that the simplest figures are the most useful, such for example as those showing the work done in handling and carting goods at stations, loading of trucks, and loading of particular trains. As regards ton-mileage, the figure which would be directly useful and readily applicable would perhaps be most easily obtained by recording the actual load contained by each truck on its outside. Where it is possible to load up trains to their maximum engine capacity, the existence of this figure handy for reference enables the actual load behind the tender to be calculated at once; and by this means a great improvement is effected on the rough-and-ready rule of 'load, so many wagons coal, so many merchandise, etc.'

C. E. VICKERS.

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REVUE DU GÉNIE MILITAIRE.

January, February, and March, 1906.

THE SIEGE OF PORT ARTHUR.—An article compiled by Colonel du Génie de Grandprey from various accounts which have been published gives an interesting description of the dynamite hand grenades that were used by both sides. The Japanese grenades consisted of tin cylinders filled with 17 ounces of dynamite; they were exploded by a detonating cap and a short length of safety fuze. The Russians used old shells and the brass cartridge cases of the 47-m.m. guns. Both sides suffered very heavily from the dynamite grenades, the Japanese in particular.

Both sides also made use of wooden mortars for throwing dynamite shells. The mortars were made in two halves, bound together with bamboo strips. The Japanese pattern were about 3 feet long, and had a calibre of $4\frac{1}{2}$ inches. The projectile was a tin cylinder, full of dynamite, and was fitted with a wooden time fuze which could be set to five distances between 250 and 450 yards. The powder charge for the mortar was adjusted to the range required.

The Japanese protected their sap heads from dynamite grenades by means of wire screens, constructed like spring mattresses, from which the grenades rebounded harmlessly. They also used similar screens to prevent the Russians setting fire to their sandbags.

Many attempts were made to destroy the Russian wire entanglements. On one or two occasions the Japanese fastened ropes to the front row of pickets, and managed to drag the whole entanglement out by the roots. After this the Russians anchored them more securely. Finally the Japanese decided that the best method was to send out men protected by steel bullet-proof shields (weighing about 40 lbs.) to cut the wire.

In attacking the permanent forts the Japanese at first mined up to the counterscarp and blew it in, thus filling up the ditch; and then tried to construct saps across the *débris*. This method met with little success, and they finally found it necessary to run their mine galleries under the forts themselves. At North Keekwan Fort they gained access to the counterscarp galleries, where some very severe fighting took place for more than a month. The fort however was not finally captured till the escarp had been mined and destroyed. The capture of 203 Metre Hill was rendered possible by the fire of the 11-inch howitzers, which destroyed the Russian shelters and communications and made it impossible for them to bring up their reserves.

The writer, commenting on the Russian defence, suggests that the position on Wolf Hill should have been more resolutely held; it was much stronger than any position in rear, and completely covered the main defences. The Russian heavy guns were too much exposed as the Russian gunners did not understand indirect laying; they were thus quite unable to cope with the Japanese artillery, which was always concealed and used indirect laying only. The Russians made great use of their Maxim guns, and were always able to bring them into action at the right moment to repel an assault; never before has Maxim fire been

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so effective. If the Russians had possessed any balloons, they might easily have located and destroyed the Japanese light railway and siege batteries.

The difference between the resistance offered by the semi-permanent and the permanent Russian works was most marked. The former were captured as soon as the attackers' trenches reached them; the latter held out for from 54 to 61 days after the enemy had gained the counterscarps. None of the permanent works succumbed until they had been mined. It is therefore as necessary as ever to instruct engineers in this form of attack. The Japanese trenches advanced at a rate of about 100 yards a day till they came within 300 yards of the Russian works, when the rate was reduced to 10 yards a day.

The writer considers that the Japanese made a great mistake in first attacking the northern section of the defence, as the western was far weaker.

March, 1906.

THE RUSSIAN MILITARY TELEGRAPHS IN THE WAR.—It was found that in connecting units smaller than a Division it was best to use telephones; but that for larger units telegraph instruments were most suitable. The telephone tempted the superior commanders to interfere too much with their subordinates. Under fire the telegraph operators were steadier and more reliable than the men working the telephones. Some of the Russian field cable was in constant use for over fourteen months. When it was too badly damaged for the telegraph lines it could still be used for telephones. They lost very little material in the retreats from Liao-yang and Mukden.

METAL GABIONS.—A description is given of a new type of gabion which is made of wire netting. The size of the mesh is ·3 inches; but even a larger mesh is said to contain the earth perfectly. The pickets consist of eight vertical iron rods, ·2 inches in diameter.

J. E. E. CRASTER.

RIVISTA DI ARTIGLIERIA E GENIO.

March, 1906.

MANCHURIAN CAMPAIGN from the middle of May to the end of August, 1905.—Capt. Giannitrapani's account of the Russo-Japanese war is brought to a close.

From the middle of April to the end of August, the operations were limited to combats of advanced posts—without any great action taking place—followed by a general advance of the first Japanese lines. The Japanese occupied Tsintsiatun* at this time with the 2nd Cavalry Brigade, infantry, artillery, and mitrailleuses; at Tschiantu was the 1st Cavalry Brigade with reinforcements. On their right wing the Vth Army Corps.

* Place names and titles are as in the original; they differ from those used in English accounts.

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which extended far towards the east in the mountains, with some detachments, attempted to advance in the valleys of the Hun, Sintsintin, and Tungvasian towards Heiluntschieng, but these attempts were rendered futile by the troops of Rennenkampf's detachments.

During the second half of May operations took place of greater importance, that is to say a new raid of the cavalry corps under Mischtschenko against Fakumen to the east of Tieling, where were found the entire IIIrd Japanese Army Corps (Nogi). The complete surprise caused to the Japanese troops by this raid would seem to show that their vigilance was neglected at this period. The object of the undertaking entrusted to General Mischtschenko was to reconnoitre the disposition of the Japanese troops on the Russian right. His force included the Cossack division of the Caucasus newly arrived on the theatre of war, and the Cossack divisions of Ural and of Transbaikal, with two horse batteries, total 50 sotnia with 12 guns.

On the 17th May this cavalry corps had succeeded in approaching the left of the Japanese lines, and passed the Liao to the north of Kupinsian, and directed itself at once towards that part of the 7th Division which was entrenched behind a fortified position. On the 18th a movement was made against Fakumen, a Japanese depôt was burned and the personnel of a field hospital were made prisoners, and long sections of the telegraph line were destroyed. On the 19th the cavalry advanced to the east of the road joining Fakumen and Sinminting, and with the assistance of a horse battery succeeded in overcoming the resistance of a Japanese infantry regiment of the 7th Division, which was protecting the roads to Skifutsi and Mukden. Taking advantage of a gap in the enemy's lines another sotnia succeeded in penetrating into the zone of the cantonments, producing further destruction. On the 20th the Russian cavalry, returning towards the west, was at Siaofaoscin, a little distance from Sinminting, where they passed the night. Then discovering the presence of other Japanese troops at Sinminting and movements of the enemy on the Skifutsi-Fakumen road, General Mischtschenko decided to retire. Without further encounters the cavalry corps on the 23rd recrossed the Liao and returned to its position on the right of the Russian army, where it was able to furnish the Commander-in-Chief with a precise report on the situation of the IIIrd Army Corps. In this undertaking the Russians lost 185 men, but captured from the enemy 2 mitrailleuses, 20 waggons, and about 200 horses; 6 Japanese officers and 234 soldiers were made prisoners.

On the eastern wing, from the middle of May to the middle of June the Russians had succeeded in repelling the advanced Japanese detachments as far as Ufanlu, and had occupied Scimiaotsi; and moreover had descended for a time into the valley of Tsin-ho that leads to Kaignan.

On the 16th June, on the western wing, another important battle took place in which the cavalry corps of Mischtschenko was engaged. This corps had recently occupied Liaoiangvoping (to the east of Tsintsiatun) and was attacked at daybreak by a Japanese infantry brigade with cavalry and artillery. The Japanese succeeded in gaining possession of the villages, but the losses were heavy on both sides.

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After the middle of June, the possibility of great tactical actions in Manchuria became more remote as the plenipotentiaries had commenced to treat for peace and the climatic conditions were unfavourable. At the beginning of July commenced the rainy season, which filled all the water courses and flooded the ground to such an extent that the communications were interrupted. Moreover the great heat in July was very unfavourable for the sanitary condition of the troops. Engagements, however, continued to take place between the advanced troops, especially on the eastern wing. The Russians continued to fortify their positions at Sipinkai, and further back to Cianciang, and more to the north near the railway bridge over the Sungari. Behind these positions the Russian army was known to have been reinforced with new corps stated to have been mobilised after the battle of Mukden.

Whilst awaiting the conclusion of the treaty of peace, engagements took place in August, some of which were of importance, between the troops of Rennenkampf and the Vth Army Corps.

On the 11th September the last battle took place in Manchuria; three Russian regiments broke through towards Ufanlu, and were repulsed by the Japanese, who, however, did not follow up their advantage.

On the 16th hostilities ceased completely owing to the conclusion of the armistice.

WATER GAS FOR HEATING AND ILLUMINATION.—It has been noted that water gas obtained by decomposing water with red hot coke costs little, and it is also observed that by mixing this gas with ordinary coal gas the heating power may be notably increased.

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,, A. A. Montgomery...Royal Field Arty.
,, F. W. Brunner.....Royal Engineers.
,, W. Robertson .....Royal Engineers.
Bt.-Major B. T. Buckley...Northumberland Fusiliers.
Capt. G. D. Jebb, D.S.O. Bedfordshire Regt.
,, J. W. O'Dowda... R. West Kent Regt.
,, J. H. Davidson, D S.O. King's Royal Rifle Corps.
,, R. J. Drake.....North Staffordshire Regiment.
,, H. E. M. Hutchinson West India Regt.
,, E. F. Orton. .....Indian Army.

THE FOLLOWING RECEIVED NOMINATIONS.

Bt.-Maj. T. A. Cubitt, D.S.O. Royal Field Arty.
Capt. M. G. E. Bowman-Manifold, D.S.O.....Royal Engineers.
,, W. E. M. Tyndall, D.S.O.....West Riding Regt.
Capt. G. J. Farmar.....Lancashire Fus.
,, R. F. Riley, D.S.O...Yorkshire Lt. Infy.
,, C. C. Newnham....Indian Army.

*Read partly at the Army College, Aldershot.

August, 1904.

SEVENTEEN passed on the Competitive List and THREE received Nominations.

August, 1903.

TWELVE passed in the Competitive List and FIVE received Nominations.

August, 1902.

ELEVEN passed in the Competitive List and FIVE received Nominations.

PROMOTION.

More than EIGHTY OFFICERS who Read with us PASSED (*d*) in May last.

WOOLWICH, DECEMBER, 1905.

THE FOLLOWING PASSED DIRECT FROM US:—

SECOND	H. G. MacGEORGE		7,196
FOURTH	G. WALTON		7,046
FIFTH	H. A. COX		6,967
16th	R. CROFTON		6,330
45th	D. STEPHENSON		5,899
54th	J. KENNEDY		5,711

SANDHURST, DECEMBER, 1905.

THE FOLLOWING PASSED DIRECT FROM US:—

SEVENTH	L. H. CRIPPS		5,144
46th	M. E. C. JOSEPH		4,336
58th	A. G. D. O'FLYNN		4,215
59th	P. J. R. WIGLEY		4,212
61st	G. C. I. HERVEY		4,187

ARMY QUALIFYING (SEPTEMBER), FOUR.

PROMOTION.

More than EIGHTY Officers who read with us PASSED (*d*) in MAY LAST.

Work for both "C" and "D" is now going on.

Militia Military Competitive, March and September, 1905.

FOURTEEN PASSED.

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